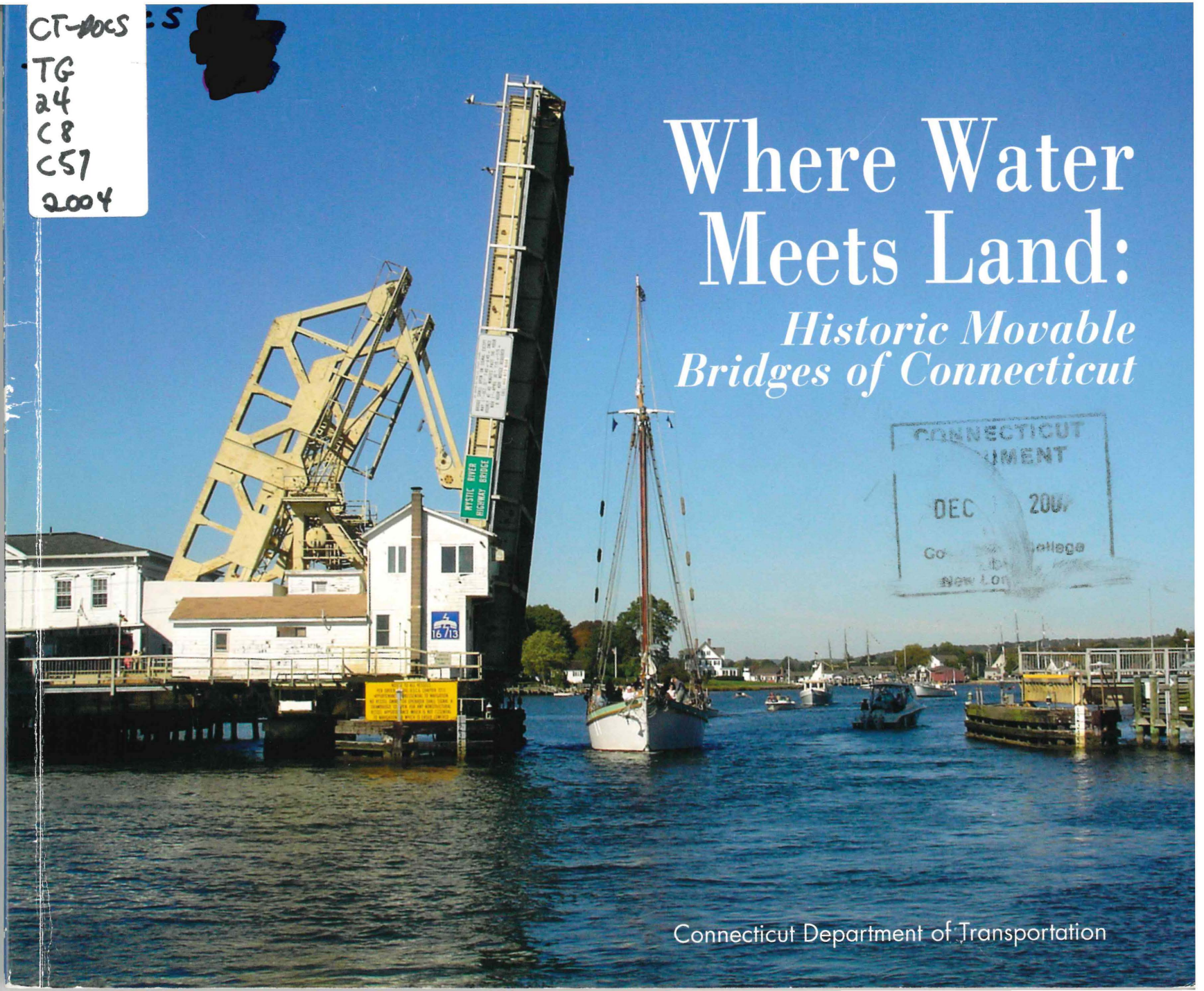
CT-DOCS
TG
24
C8
C57
2004




# Where Water Meets Land:

## *Historic Movable Bridges of Connecticut*

CONNECTICUT
DEC 200
College

Connecticut Department of Transportation

# Where Water Meets Land: Historic Movable Bridges of Connecticut

by
Bruce Clouette

CONNECTICUT DOCUMENT
DEC 0 6 2007
Connecticut College Library
New London, CT

U.S. Department of Transportation
Federal Highway Administration

Published by the
Connecticut Department of Transportation
in cooperation with the
Federal Highway Administration

2004

## ACKNOWLEDGMENTS

Many people have had a hand in making this document a reality. The initial idea came up in discussions between Keith T. Hall, Transportation Supervising Planner, Office of Environmental Planning, Connecticut Department of Transportation (CONNDOT), and David Poirier, Staff Archaeologist with the Connecticut State Historic Preservation Office. Other staff members at CONNDOT and the Federal Highway Administration helped by reviewing drafts of the text, including Paul L. Sabrosky, who carefully edited the entire publication. Robert Moore, CONNDOT photographer, was instrumental in locating historical photographs, and the author received additional help from archivists at the Connecticut Historical Society and Connecticut State Library.

Many of the bridges highlighted herein have been the subject of intensive research for Historic American Engineering Record (HAER) documentation. The author wishes to explicitly acknowledge the following persons who prepared HAER reports for historic Connecticut movable bridges: Janice G. Artemal, Mary Dieter, Gregory Galer, Keith T. Hall, Robert Stewart, Frederic Warner, and Jenn P. Yearby.

Several people at Public Archaeology Survey Team, Inc., a nonprofit research and educational organization in Storrs, Connecticut, were instrumental in producing this publication. Elizabeth Fuchs assembled the initial data and organized a file system for the project. Brian Lever and Arianne Corrente wrote first drafts of some of the individual bridge entries based on the author's previous surveys. Lisa Centola and Timothy Kuskowski took many of the photographs and shared in the fieldwork, and Heather Alexson proofread the text. Finally, Mary Guillette Harper was responsible for the administrative aspects of the project.

Whatever shortcomings remain should be chalked up solely to the author's account.

Design by Tomolonius Design.

*Front cover:* The Route 1 drawbridge in Mystic opens to allow a sailboat to pass.

*Back cover:* Amtrak's Acela passes over the Niantic River Railroad Bridge (Douglas Kroll photograph).

Except as otherwise noted, all photos by PAST, Inc.

# CONTENTS


1 . . . . . Introduction

4 . . . . . Historical Background

19 . . . . . Connecticut's Movable Highway Bridges

49 . . . . . Connecticut's Movable Railroad Bridges

72 . . . . . Glossary

77 . . . . . Bibliography

78 . . . . . Movable Bridges Listed on the National Register of Historic Places

79 . . . . . Movable Bridges Recorded by the Historic American Engineering Record

80 . . . . . Index Map

# INTRODUCTION

By 1990, Bridgeport's historic Grand Street Bridge was at the end of its lifetime. Construction of the bridge had started in 1916, when Bridgeport was in the midst of the greatest industrial build-up it had ever seen. Military preparations for America's entry into World War I had begun, and because of the collapse of European industrial output, American factories were running day and night. This put a tremendous strain on the infrastructure of industrial cities like Bridgeport. In order to keep up with both increased truck traffic and the shipment of coal and other raw materials by water, new bridges were needed across the Pequonnock River, ones that could be raised to allow vessels to reach the munitions factories on the upstream banks. The Grand Street Bridge was especially important because Grand Street and the river both served the immense plant of the Bridgeport Brass Company. The bridge was still incomplete by the time the war ended, but for the next 70 years, it provided a useful link in the city's transportation system and served as a reminder of Bridgeport's role as an industrial powerhouse, especially in times of war.

◂ *Bridgeport's Grand Street Bridge (HAER photo, 1995, by Wayne Fleming).*

*Typical swing bridge in the open position (HAER photo, 1978, by William E. Barrett).*

Over the years the bridge and its mechanical and electrical systems had deteriorated, and engineers determined that it would no longer be economical to repair or even maintain the structure. In order to create a permanent record of the bridge, the Connecticut Department of Transportation (CONNDOT) arranged to have high-quality photographs taken of the bridge which, along with narrative text that explains its historical significance, were archived as part of the Historic American Engineering Record (HAER) maintained by the Library of Congress in Washington, D.C. At the same time, the Connecticut State Historic Preservation Office, the state agency that oversees historic preservation programs in Connecticut, suggested a publication aimed at the general public that would highlight not just the Grand Street Bridge, but also other historic movable bridges in the state.

*Typical bascule about halfway open.*

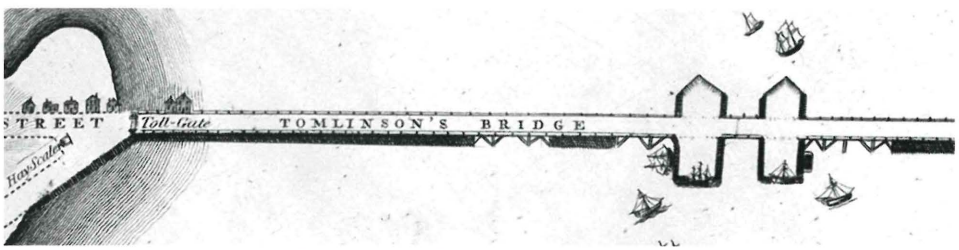
This book, produced by CONNDOT in cooperation with the Federal Highway Administration, is intended to provide a compilation of essential information on Connecticut's historic movable bridges. It is a companion to *Historic Highway Bridges of Connecticut*, issued by CONNDOT in 1991, and follows much the same format. However, because many of the state's movable bridges, such as the one on Grand Street, had become deteriorated or functionally inadequate, it includes information not only for the surviving examples but also for those that have been removed or replaced in recent years. It is hoped that this book will provide a fond look back at those bridges that are no longer with us, and also a renewed appreciation for the age, mechanical complexity, and historical significance of the movable bridges that remain.

*The term "movable bridge" denotes any type of bridge that can be opened to allow traffic below (usually on a navigable body of water) to proceed. The two most common types in Connecticut are bascules, bridges that pivot at one end and can be raised up like those over the moats of medieval castles, and swing bridges, which pivot at the center and swing open so that they are parallel to the channels.*

# HISTORICAL BACKGROUND

The movement of goods and people by water has long been an important theme in Connecticut history. The state has miles of coastline along Long Island Sound, where the many river outlets and well-protected harbors encouraged people to engage in trade, build vessels, and exploit various estuarine and off-shore fisheries. In addition, three of Connecticut's rivers – the Housatonic, Connecticut and Thames – are large enough that sailing vessels could venture far upstream, allowing maritime interests to develop in such "inland" towns as Derby, Middletown, Hartford, Windsor, and Norwich. Starting in the early Colonial period, some Connecticut residents were able to prosper by shipping meat, grain, and timber to the West Indies, while others turned to building wooden sailing vessels. Imported goods from Europe also arrived by water, either directly or by being brought in via the coastal trade with Boston, Newport, New York and Philadelphia.

The downside was that the same waterways that encouraged the development of Connecticut's maritime economy impeded travel by land, especially east-west travel (most Connecticut rivers flow from the north to the south). In the 18th century rivers large and small were commonly crossed by ferries, not bridges, so other than the inconvenience of having to wait for the ferry boat, there was little conflict with the needs of navigation. Once bridges appeared, however, the needs of water-borne commerce and land travel came into opposition. Until




*Plan view of the first Tomlinson Bridge, as drawn by Amos Doolittle, 1824. The lattice-truss and king post-truss approach spans are shown in profile.*

*The little wooden swing bridge at the east end of the 1818 Hartford Bridge was the only portion to survive the fire of 1895 (The Connecticut Historical Society, Hartford, Connecticut).*

the 20th century, it was rarely possible to build a bridge high enough over a river or harbor channel so that vessels could pass underneath. Unless a bridge had a portion that could be opened to allow vessels through, it would effectively block water access to the areas upstream. Even with a draw span, navigation was somewhat restricted, both by the width of the draw span and by the need to wait for it to open (at which point the bridge became an impediment, or at least an irritant, to those on land waiting to cross).

It is difficult to say when Connecticut's first movable bridge was built; it could well be that there were one or more small bridges across harbor channels that have disappeared from memory. One of the first known drawbridges was Tomlinson Bridge in New Haven, first constructed in 1797. Like most major bridge projects of the 18th century, it was built not by the state or local government but by a private company, in this case led by Isaac Tomlinson. Previously, Tomlinson and his associates had operated a ferry between the built-up part of New Haven and the section across the Quinnipiac River known as Fair Haven. In exchange for building and maintaining the bridge, Tomlinson and company were granted the right to charge tolls for pedestrians, horses, and carriages crossing the river. Most of the bridge consisted of a series of short timber spans set on piles, but there also was a draw span to allow vessels to go further up the river. Similarly, when the Hartford Bridge Company was granted permission to erect a toll bridge between Hartford and East Hartford in 1816, the State required the company to maintain a draw on the west side so that vessels could pass through on their way to what is now Warehouse Point, the head of sloop navigation on the Connecticut River.

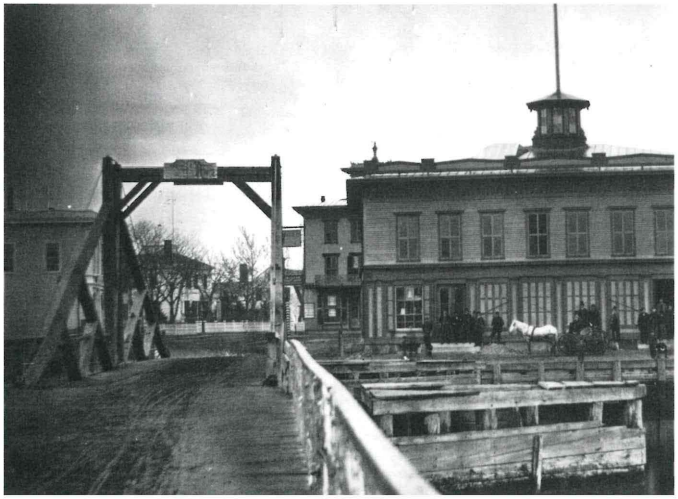
We have little detailed knowledge of what these early drawbridges were like. There were only two bridge-building materials

available, stone and wood, and because stone is hardly suitable for a moving bridge, we can be certain that they were all timber structures. We know from early sketches that the movable portions were small. Because they were operated by hand, using ropes and windlasses, the movable portions of the bridges could not be very large, but they didn't need to be.



By modern standards, sailing vessels were remarkably small; even an ocean-going schooner like *Amistad* would be only 25 to 30 feet wide at its widest point. Some of the early wooden drawbridges were bascules, that is, bridges that were hinged at one end and pulled open by raising the other end like those over the moats of medieval castles. Others were swing bridges, pivoting at the center or at one end. Wooden bridges were not very durable. The joints holding the various timbers together tended to loosen over time. Rain, snow and freezing weather accelerated their deterioration. Wooden drawbridges were probably even more vulnerable than fixed timber bridges because of the strain of opening and closing. The end result was that early drawbridges tended to need rebuilding every 20 to 30 years.

The advent of railroads in Connecticut, starting in the late 1830s, added to the stock of drawbridges. The state's largest rivers were not crossed by rail lines until the end of the 19th century. Instead, both freight and passengers were carried across by railroad car ferries. The railroads crossed the smaller navigable rivers, particularly those that



*In the 1850s, the bridge at Mystic was a large timber-truss swing bridge (Photograph © Mystic Seaport, Mystic, CT, #1976.171.168).*

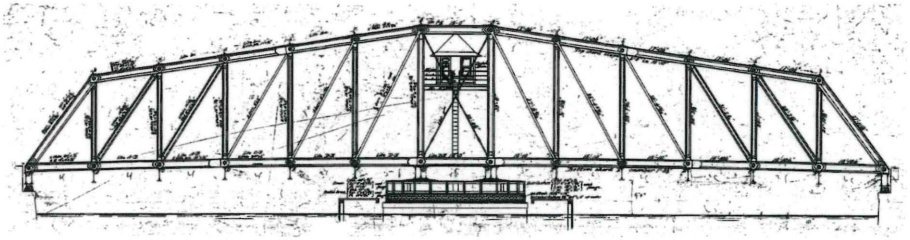
formed parts of the many harbors along the shoreline, on wooden swing bridges. One of those early swing bridges was the site of Connecticut's first great railway disaster. In 1853, the bridge over the Norwalk River was left open despite the approach of a passenger train from New York City. The locomotive and several cars plunged into the water, killing 45 people.

## Iron and Steel Trusses

After the Civil War, iron trusses revolutionized bridge-building throughout America. Complex trusses a hundred or more feet long had been built out of wood;

*Postcard view of the original Thames River railroad drawbridge.*

many endure today in New England as the familiar covered bridges. Iron, however, is many times stronger than wood and is resistant to the decay and impact damage that shortened the lives of wooden bridges. In the 1860s and 1870s, the iron industry in America came of age. It had originated serving the needs of railroad construction, but the same rolling mills that produced rails could be configured to make bars, rods, angles, channels, plate and other wrought-iron components that could be assembled into a strong, durable truss. Engineer-entrepreneurs established fabricating companies, enterprises that bought iron in its basic forms and made it into beams and trusses that could be used for roofs, building frames, and bridges. At first their only customers were railroads, willing to pay extra for iron bridges so as not to have to maintain and replace timber structures, but as the price of iron bridges dropped, local highway officials became interested as well. Once iron



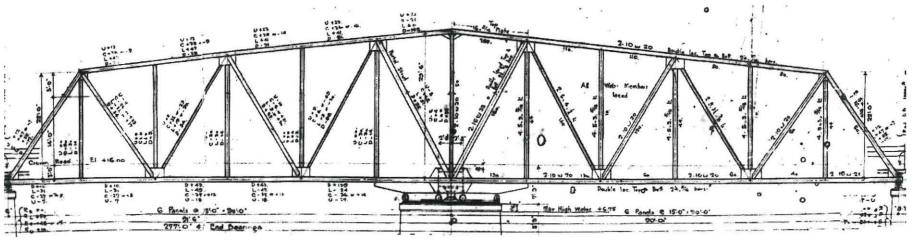
*A Pratt-truss swing span (Chapel Street, New Haven).*

trusses became competitive in price, there was little reason to build in wood.

Most if not all of the drawbridges built in Connecticut after the Civil War were made of iron. In the 1870s and 1880s, the railroads bridged the Housatonic, Connecticut, and Thames Rivers with large iron swing bridges, and highway officials in some of the state's maritime communities also turned to iron swing bridges to replace old wooden draw spans. One of the earliest was the 1868 drawbridge across the Mystic River separating Groton and Stonington, a truss built according to a patented design invented by Lucius Truesdell of Warren, Massachusetts. Like earlier wooden swing bridges, it had a center tower from which the truss was suspended by cables as it swung open. The Truesdell truss combined cast-iron and wrought-iron components in a manner that was less than scientific; at least one Truesdell truss was involved in a spectacular fatal collapse. Nevertheless, the Mystic Bridge soldiered on for more than 30 years without incident, by which time it was regarded as too narrow for traffic that included electric streetcars as well as horse-drawn vehicles and pedestrians.

Although in common usage one speaks of a swing bridge as a truss, almost all consist structurally of two trusses joined together in the center, over the pivot pier. Like any fixed truss, the two halves of a swing bridge transfer the load of crossing traffic to the ends of the bridge where it bears on masonry abutments or piers. In a swing bridge, the difference comes in when the bridge is opening; then, the trusses must support their own weight (the bridge's "dead load") entirely at the center

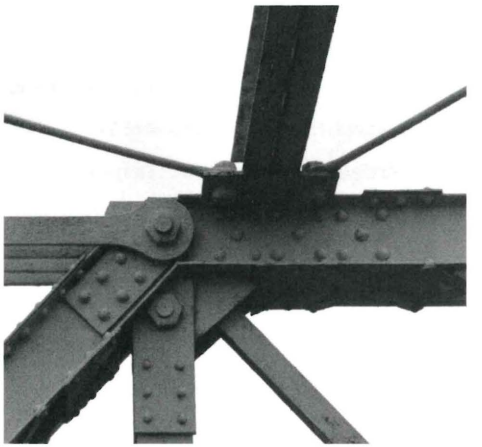
*In the late 19th-century, the drawbridge at Mystic was an iron Truesdell truss (Photograph © Mystic Seaport, Mystic, CT, #1994.18.50).*



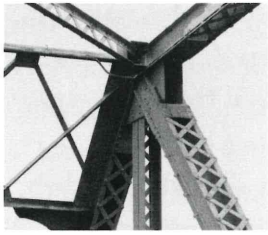
*A Warren-truss swing span (Niantic River, East Lyme).*

of the bridge. Usually when a swing bridge is completely open, the ends come to rest on an extra set of piers aligned with the center pier, but for a while the ends are completely unsupported as the bridge swings through its arc. Some swing trusses reflect this special circumstance in their design; the end panels may have different or additional structural components to account for the stresses when the bridge is opening and they are unsupported, and the panels may increase in depth toward the pivot pier, which has to bear the whole dead load of the bridge when opening.

Swing-bridge trusses became more standardized as the years went by. The early use of cast iron for compression members disappeared as equivalent components made of wrought iron, a material that was far less brittle, became available. The numerous patented truss designs that had characterized the early days of iron bridge-building, many of which required special connectors, gave way to a few standard types, notably the Pratt and Warren truss patterns. The debate among engineers whether trusses should have their components joined together by large pins and nuts, or riveted together using gusset plates, was finally resolved in favor of riveted connections. Pinned connections were favored by some engineers because they were thought to transmit forces better than riveted joints, and they were easier to erect from pre-assembled components. Most 19th-century swing bridges used pin connections, but after 1900 or so, riveted connections were chosen for all but the largest trusses. All agreed that



*Typical pinned connection (Saugatuck River Swing Bridge, HAER photo, 1990, by Robert Moore).*



*Typical riveted connection (Niantic River Swing Bridge, 1986, HAER photo by Guy Freeman).*

riveted bridges were more rigid, a characteristic that was especially important for railroad use, and once field-riveting technology became perfected and widely available, they were as easy to erect as pinned bridges. The East Haddam Bridge, at 456 feet, is the longest swing span in Connecticut. Completed in 1913, it combines pinned and riveted construction.

The mechanical aspects of swing-bridge technology also underwent a process of refinement. A swing bridge's operating mechanism typically consisted of one or more electric motors and several stages of shafts, bevel gears, and reduction gearing, terminating in a pinion gear that engaged a large ring gear fixed to the central pivot pier. Although the principle remained unchanged, engineers devised numerous innovations for controlling the motors, braking the bridge so that its momentum did not get out of control, and providing for manual override in case of power failure. Another area that received attention from engineers was improving the wedge mechanisms: wedges were used to raise the ends of a swing bridge in the closed position to take the load off the rollers and transmit it to the piers or abutments. Various types of lever-action and screw-type wedge drivers were tried in an effort to improve reliability and operating times.

Probably the greatest single improvement in swing-bridge technology was the development of the center-bearing pivot. Previously, in what is called a rim-bearing design, the weight of the rotating bridge had been borne by a series of rollers along the circumference of a large drum-like structure; the rollers ran in a circular track atop the pivot pier. Metallurgical advances, notably the develop-

ment of phosphor bronze alloys at the end of 19th century, allowed the design of bearings with much greater capacity, and it was found that a single large center bearing could support the entire weight of the bridge as it turned (rim rollers were still provided to correct for imbalances as the bridge swung open). Most 20th-century swing-bridges were center-bearing designs. The Air Line railroad bridge in Middletown, for example, completed in 1910, turns on a center bearing consisting of a 30-inch-diameter phosphor-bronze disk sandwiched between two steel plates. The center-bearing design had a lower initial cost and allowed for a smaller pivot pier than the rim-bearing type; it also required less power to turn the bridge. Because there were fewer critical parts, the center-bearing type was also less expensive to maintain. However, the center bearing had to be adequately sized and provided with proper lubrication; otherwise it would wear out quickly.

## Bascules

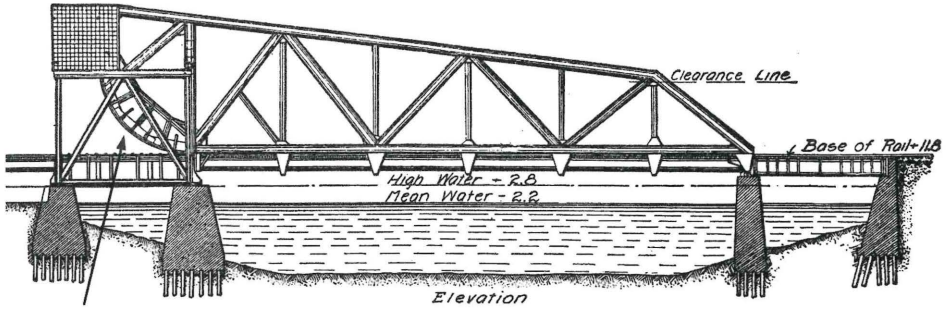
In the 1890s and early 1900s, bascules began to eclipse swing bridges, particularly in densely settled urban areas. Bascules represented an updating of the medieval drawbridge concept: a bridge that was hinged at one end and opened by raising the other end. In place of wooden construction and chains, turn-of-the-century bascules substituted steel-girder or truss superstructures, electric motors, and geared drive trains. Despite the weight of the moving bridge, not a great deal of power was required to operate a bascule because the opening leaf was balanced by a heavy counterweight constructed of iron plates or concrete. The modern bascule was developed first in Chicago, a city characterized by numerous narrow shipping channels, a dense network of rail lines, and a dense grid of streets. In Connecticut, highway bascules are concentrated in Bridgeport and New Haven. Like Chicago, these two cities are

characterized by large-scale industrialization, dense urban development, and narrow channels leading from their harbors.

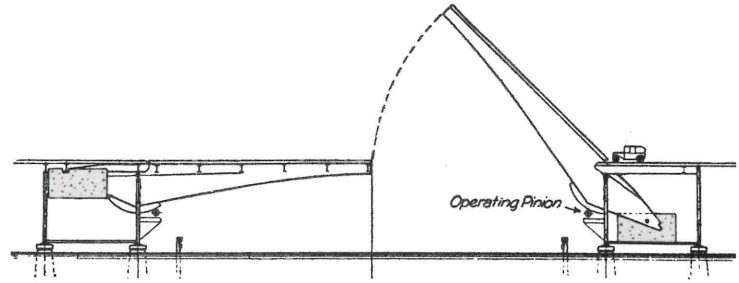
Bascules offered many benefits: they provided a single wide channel rather than the two narrower channels created by a swing bridge, their operating time was faster (though their power consumption was a little more), and they were less expensive to maintain. In addition to eliminating the center pier, there was no need for the swing bridge's rest piers, which could be a danger to navigation. Finally, the cost of a swing bridge went up dramatically as the roadway it carried became wider; they might have been competitive for single-line railroad tracks or ordinary streets, but wide avenues with streetcar tracks or multi-track rail lines made the bascule a more economical choice. It was claimed that bascules also had the advantage that, should the need arise, a parallel bascule could be built alongside to address the needs of increased traffic, whereas a swing bridge would require a complete replacement. While such parallel bascules were built in some locations, no Connecticut bascules were widened in this manner. However, a number of Shore Line railroad bridges were built as two parallel two-track bascules; this allowed them to work independently.

The first bascules, eventually known as the "Chicago-type" or simple-trunnion design, were straightforward structures with a fixed counterweight at the end of






*Schematic of the Scherzer Rolling Lift Bascule, with an arrow indicating the large segmental girder on which the bridge rolls back.*




*Schematic of the Strauss underneath counterweight design.*

the leaf and a pivot or trunnion at the center of gravity. Soon, however, engineers devised a variety of refinements intended to improve on the basic bascule. One textbook listed 114 separate patents issued in this period relating to bascule bridges. In addition to complicated systems for linking the counterweights and bascule leaf, these innovations included improvements to drive mechanisms and the locking mechanisms that secured the ends of the bascule leaves when closed.

One of the most popular patented designs was the Scherzer Rolling Lift concept, in which the bascule leaf, instead of pivoting on a trunnion, rolls back from the channel on huge curved segmental girders that run in a track on the adjacent fixed span. William Scherzer built the first rolling lift for the Chicago Metropolitan West Side Elevated Railroad in 1893 and later patented the design and several refinements. The Scherzer bascule had a low initial cost, required less power than other bascules, and provided a wider clear channel because it actually moved back as it lifted. Its disadvantage was that is created horizontal stresses on the piers and so was not suitable where the piers had to be on piles. Many of Connecticut's Shore Line railroad bridges are Scherzer Rolling Lift bascules.

Also popular were the various designs of Joseph B. Strauss. Strauss's approach was to have the counterweight move independently of the bascule leaf, either by pivoting on the end of the leaf or supported independently and connected to the leaf by means of links forming a parallelogram. In the case of the Strauss undergrade counterweight type, several of which were built in Bridgeport and New Haven, the horizontal movement of the pivoting counterweight allowed for a low-profile bridge without the expense of the deep, watertight counterweight compartments needed by a simple-trunnion design. The Thames River Railroad Bridge also uses a Strauss design, one with a separately

moving linked counterweight. Together the Scherzer and Strauss designs account for the majority of bascules in Connecticut as they did nationwide. (In addition to his contributions to the refinement of the bascule, Joseph B. Strauss is remembered today as the engineer for San Francisco's Golden Gate suspension bridge.)

Less common but equally interesting mechanically were the innovations of Thomas E. Brown. Brown came rather late to bridge design, having already had an illustrious career as the chief of mechanical engineering for Otis Elevator, in which capacity he designed the inclined elevators that rose through the legs of the Eiffel Tower. Brown received several bascule-bridge patents which, like those of Strauss, allowed for the separate movement of counterweight and bascule leaf. His "Balance-Beam" design for the Route 1 bridge in Mystic (1922) was celebrated for its low initial cost, ease of access to key components, and compact operating mechanism. The counterweights move through an arc of only 69 degrees, while the bascule leaf has a full 90 degrees of motion.

## A New Role for the State of Connecticut

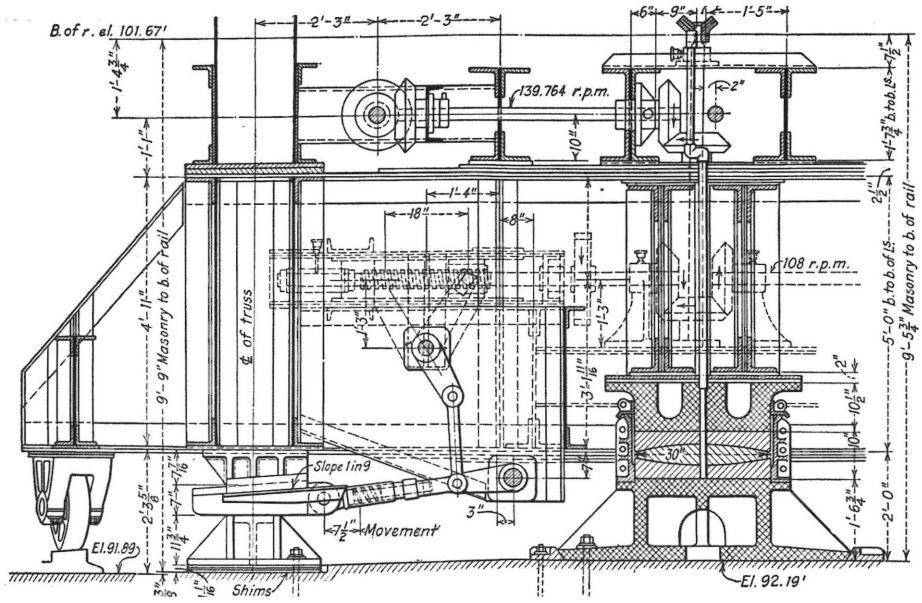
Although a state highway department was created in 1895 to improve Connecticut's major roads, the state government took no general responsibility for constructing or maintaining bridges. Instead, the Legislature created special commissions when the need arose to build bridges across the major rivers. The first of these was the Hartford Bridge, later known as the Bulkeley Bridge, completed in 1908 over the Connecticut River between the towns of Hartford and East

*Route 1 bridge at Saybrook, replaced by a high-level crossing in the 1940s (Photograph © Mystic Seaport, Mystic, CT, #77.108.6).*

Hartford. The $3 million cost of the bridge was divided up among those two towns, other towns in the Hartford area, and the State; much of the money came from a special levy on the Connecticut Company, which ran its streetcars over the bridge. Two other bridges over the Connecticut River were completed in this way in 1911 (Old Saybrook-Old Lyme) and 1913 (East Haddam-Haddam). In 1915 the Connecticut Highway Department was given authority over all bridges on the state's "Trunk Lines," the major highways that served many towns and knit the state together. The state-highway engineers immediately adopted as their first priority replacement of inadequate bridges along Route 1, also known as the Boston Post Road, the state's major east-west route paralleling the Long Island shoreline.

Material shortages during World War I delayed the State Highway Department's bridge efforts, but by the early 1920s a number of major projects had been completed, including two large movable bridges, the Washington Bridge across the Housatonic River between the towns of Milford and Stratford and the Route 1 Mystic River Bridge between Groton and Stonington. Both were bascules and were celebrated as evidence of the state government's commitment to modernizing Connecticut's highway system.

Many of Connecticut's movable bridges were described in *Engineering News* and other technical periodicals, and some were used as examples in the leading textbooks of the day. The superstructure, center bearing, and operating machinery of the New Haven Railroad's Air Line swing bridge at Middletown was described at length in Otis E. Hovey's *Movable Bridges* (1927), as was the Thames River Railroad Bridge. The Washington Bridge over the Housatonic River appeared in J.A.L. Waddell's *Economics of Bridgework* (1921) as an example of calculating the




*The mechanism of the Middletown Railroad Bridge was used to illustrate the center-bearing principle in Otis Hovey's* Movable Bridges *(1927).*



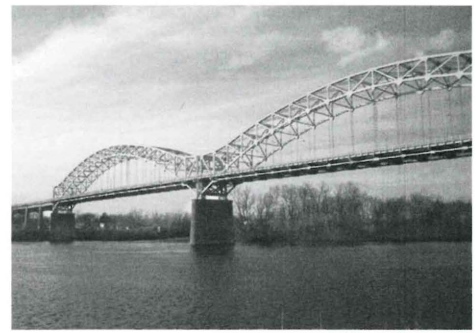
relative costs of bascules and vertical-lift bridges, and the Route 1 Mystic River Bridge was featured prominently in both *Economics of Bridgework* and Hovey's *Movable Bridges*.

## Conclusion

The flurry of movable-bridge building that occurred in the early years of the 20th century was mostly over by the 1930s. For one thing, just about every crossing in Connecticut that needed a movable bridge had one of reasonably recent construction. Also, faced with burgeoning motor vehicle traffic, state highway officials wanted to avoid the interruptions of bridge operations wherever possible. When the time came to build bridges for the state's parkways, the Connecticut Turnpike, and other highway projects of the 1940s and 1950s, the engineers almost always chose high-level crossings. The Charter Oak, Arrigoni and Baldwin Bridges across the Connecticut River, the Sikorsky Bridge across the Housatonic River, and the Gold Star Bridge across the Thames River are early examples of the trend; all are so high above the water that they present no obstruction to navigation in the channel below.

High-level bridges were not practical for railroad crossings or crossings in densely settled urban areas, and they were too expensive for secondary roads, so many of the state's movable bridges remained in service until the recent past. Inevitably, structural and mechanical deterioration

reached a point beyond which it was no longer feasible to rehabilitate them, and in the 1990s a number of Connecticut's historic movable bridges were demolished to make way for modern replacement. In one case in New Haven, the historic bridge was faithfully reproduced using modern high-strength materials, and along the railroad Shore Line, modern swing trusses at least capture the flavor of the older bridges at those locations. In other cases, traffic needs have grown so much that the bridges have been replaced with much larger structures, such as the new vertical-lift Tomlinson Bridge in New Haven. In every case, prior to major alteration or demolition, a photographic record has been made of the historic bridge so that its distinctive characteristics can be appreciated by future generations. Many of these photographs, obtained from the federal Historic American Engineering Record or the Connecticut Historic Preservation Collection at the University of Connecticut, have been used in this book to illustrate historic movable bridges that no longer exist.



*The Arrigoni Bridge, Portland-Middletown, built in 1938.*

# MOVABLE HIGHWAY BRIDGES

Among Connecticut's oldest movable bridges are the iron-truss swing bridges built in the late 19th century across the rivers and inlets of seaport towns. In many cases, these replaced earlier iron or wooden bridges that had outlived their usefulness. Two of New Haven's 19th-century swing bridges were replaced in the 1990s, leaving only Westport's wrought-iron Saugatuck Swing Bridge, built to be powered by hand, still in service.

In the early part of the 20th century, Bridgeport and New Haven built a number of movable bridges across the channels that form parts of those cities' busy harbors. Bridgeport was particularly highly industrialized and needed to accommodate both the truck traffic that served its many factories and the barges and other vessels bringing in coal and raw materials. In the years just before and after World War I, Bridgeport built four bascules to carry city streets over waterways.

Another large group of bridges were those built in the early 20th century by the state government to improve major east-west highways. The first of these, such as the East Haddam swing bridge across the Connecticut River, were built by specially formed bridge commissions. But in 1915, the State Highway Department was given authority over all the state's major river crossings and so could undertake a comprehensive plan of bridge-building. In short order, new movable bridges were provided for the navigable rivers crossed by U. S. Route 1 along the Connecticut shore, mostly of bascule design. Two of these, the 1921 Washington Bridge across the Housatonic River and the 1922 Mystic River Bridge, remain in service and two others, in New Haven and East Lyme, have only recently been replaced.

Beginning in the 1930s, high-level highway crossings made many of the state's movable bridges obsolete. The first was the twin-arched Arrigoni Bridge (1938) across the Connecticut River between Middletown and Portland. Built to replace an earlier swing bridge, it provides some 90 feet of clearance for boats on the river. Other high-level crossings replaced movable bridges at Old Saybrook and New London, and new river bridges for the Merritt and Wilbur Cross Parkways were built high enough to avoid the need for a movable section. Today the high-level bridge is the preferred choice for crossing a navigable waterway.



◂ *Tomlinson Bridge, New Haven, HAER photo, 1966, by Robert Moore.*

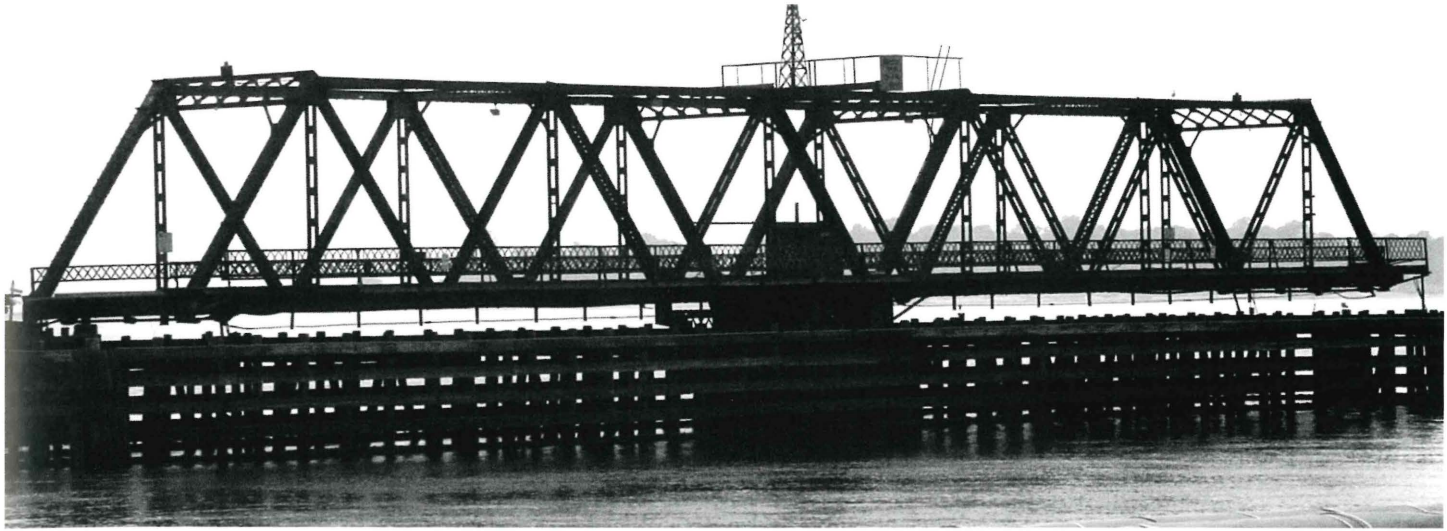
## PLEASURE BEACH BRIDGE (Bridge No. 4455)

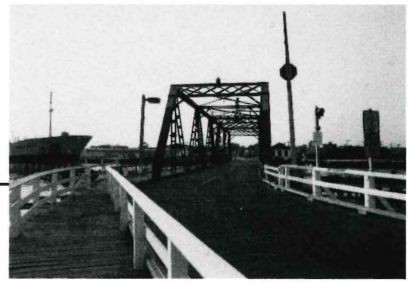
- Central Avenue over the Lewis Gut
- Bridgeport
- Riveted Warren through-truss
- Length: 57 spans, 1,257' overall, 70' swing span
- Built in 1927

*Pleasure Beach Amusement Park, ca. 1940 (Andrew Pehanick Collection).*

Pleasure Beach Bridge in Bridgeport recalls the days of trolley car rides to the amusement park on hot summer evenings. Although not much can be seen there today, Pleasure Beach was once a fun-filled attraction featuring a midway, food vendors, a carousel with brightly painted carved horses and band organ, and a large dance hall, as well as a long sandy beach facing Long Island Sound. In the 19th century, visitors could only reach the park by ferry, but in 1907 the Pleasure Beach Ferry Company received a charter to build a toll bridge. It had to be a movable bridge in order to maintain navigation between Bridgeport Harbor and the nearby Johnson Creek industrial area, so the company built a long series of trestles across the shallow tidal flats and a swing span across the dredged ship channel. In addition to automobiles and pedestrians, the toll bridge carried trolleys that connected with the city's street-car system. The first swing span was reconstructed in 1927. When the ferry company fell on hard times during the Depression, the city took over the bridge and made it free of tolls. The Pleasure Beach amusement park closed in 1968; although the carousel and other buildings are now gone, the beautifully restored carousel horses are on display at Bridgeport's Beardsley Zoo.

Most of the bridge is made up of steel beams supported by timber pilings sunk into the shallow





*Pleasure Beach Bridge in 1991, showing the wooden approaches that have since burned (HRC Photo).*

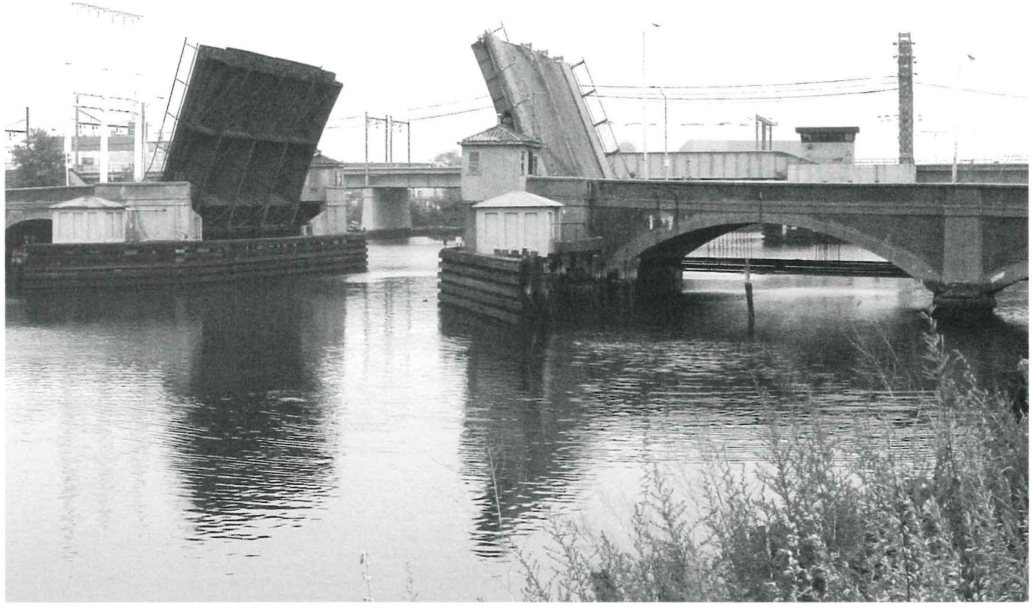
waters. The swing span has two separate three-panel Warren through-trusses connected by steel beams at the upper end joints. A wooden sidewalk is cantilevered from the west side of the bridge on brackets built up of steel angles. The swing span pivots on a circular reinforced-concrete pier surrounded by wooden fenders. The bridge operator's house is located at the end of the mainland approaches, rather than on the swing span itself.

The bridge was heavily damaged by fire in 1996 and is now closed.

# CONGRESS STREET BRIDGE (Bridge No. 4251)

- Congress Street over the Pequonnock River
- Bridgeport
- Deck-girder Scherzer rolling-lift bascule
- Length: 5 spans, 425' overall, 86' double-leaf bascule
- Built in 1909-1911
- Fort Pitt Bridge Works, fabricator





The first in a series of bascules built by the City of Bridgeport, the Congress Street Bridge stands as an example of the innovative design that characterized movable-bridge technology around the turn of the 20th century. Compared with other types of bascules, the Scherzer rolling-lift design, perfected in Chicago in the 1890s, gives a greater clearance for the waterway as it rolls back, and it avoids carrying the weight of the bridge on a single rotating pivot. Although this saves the cost of high-stress pivot bearings, the Scherzer bascule requires the adjacent girder span to have substantial foundations to support the weight of the bridge as it rolls back. Despite this requirement, the Scherzer design was probably the most frequently chosen movable-bridge design of the period.

The special commission set up by the city in 1909 to oversee the Congress Street project hired a local engineer, Raymond F. Stoddard, as the overall design consultant. Stoddard in turn obtained a license to use the patented Scherzer design for the double-leaf bascule and retained the prominent Boston engineering firm of J. R. Worcester and Company to design the concrete-arch approach spans. The bridge was opened in 1911.

Bridgeport was Connecticut's most highly industrialized city during the early 20th century, with several navigable channels serving large-scale manufacturers, so it is no wonder that the city invested in so

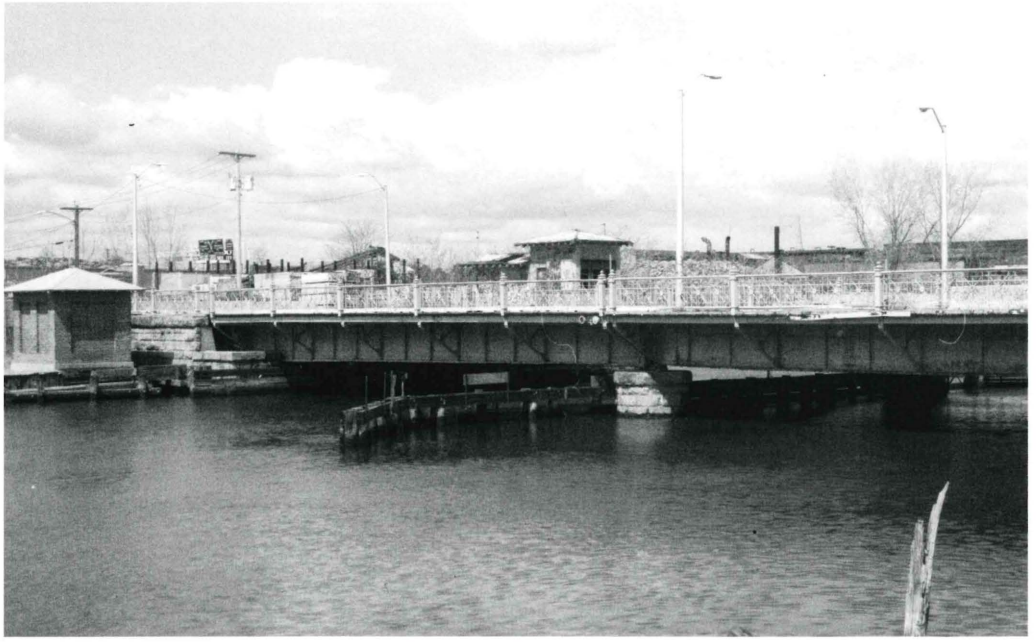
many movable bridges. The Congress Street Bridge cost nearly $300,000, a substantial sum in those days. A portion of the construction cost was contributed by the Connecticut Company, which operated the trolley system in Bridgeport at the time. The bridge's 55-foot width reflects the fact that it was designed to carry streetcar traffic along with pedestrians and vehicles.

In recent years, Bridgeport's oldest movable bridge has become increasingly in need of repair. It is now closed, and traffic has been diverted to the East Washington Avenue Bridge.

## EAST WASHINGTON AVENUE BRIDGE (Bridge No. 4252)

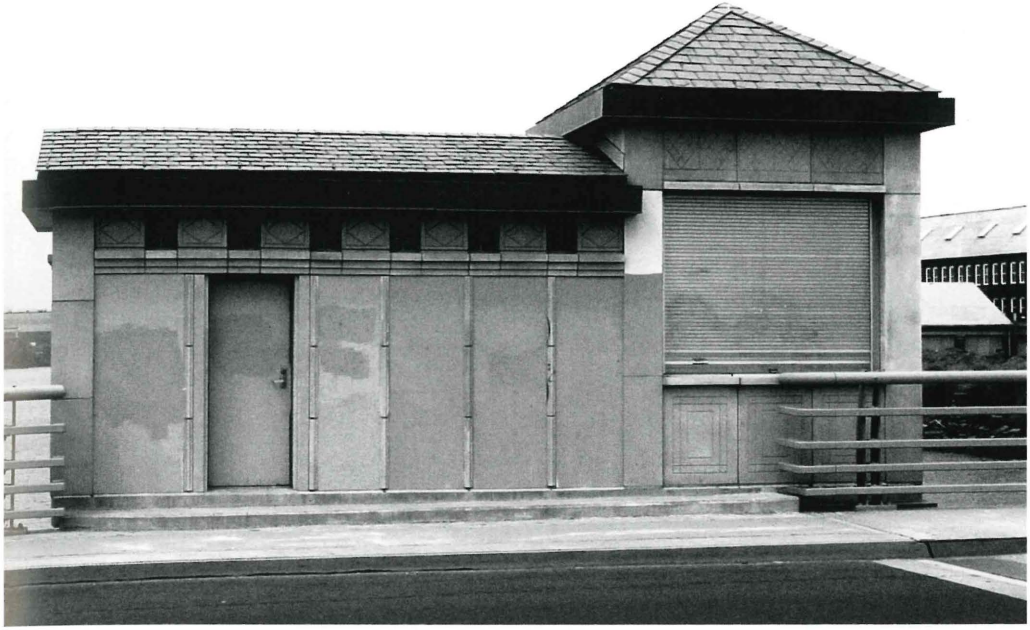
- East Washington Avenue over the Pequonnock River
- Bridgeport
- Strauss underneath-counter weight deck-girder bascule
- Length: 3 spans, 203' overall, 87' bascule
- Built in 1925
- Penn Bridge Company, fabricator
- Replaced in 1998





*HAER photo, 1996, by Robert C. Stewart.*

Bridgeport's economy boomed in the World War I period, as American manufacturers took up the slack created by the devastation in Europe. Along with prosperity came increased traffic, both surface transportation and the movement of material on the city's waterways. To better serve the many factories involved in war-related production, the city in 1916 bonded $250,000 for three modern bascule drawbridges, including a replacement for the old swing bridge that carried Washington Avenue over the Pequonnock River. City Engineer James A. McElroy drew up specifications for the bridge, and the steel components were ordered from the Penn Bridge Company. However, trouble with the contractor over the first of the three bridges forced work to stop on the whole project. While the war came and went, the old swing bridge continued to serve East Washington Avenue, and despite the fact that everything had been made and was sitting in Beaver Falls, Pennsylvania, the city lacked sufficient funds to erect the bridge. Finally, the state in 1923 appropriated $350,000 to finish the project, and a new company, Bridgeport Dry Dock and Dredging, took over. The material was shipped to the site, work began in mid-1924, and the bridge was opened to traffic in 1925. Originally, it was designed to carry streetcar traffic, but by the time it was finished, trolley service in this area had been discontinued.



*Restored operator's house-toilet building.*



The East Washington Avenue Bridge was an example of the underneath-counterweight design patented by Joseph B. Strauss, one of the major innovators in bascule development and later the engineer for San Francisco's Golden Gate Bridge. Strauss pioneered the use of concrete (rather than iron plates) for counterweights, and he came up with an intricate folding-trapezoid linkage between the counterweight and the bascule that minimized the travel distance of the counterweight, yet kept the bascule leaf in perfect balance. In the underneath-counterweight variation, the result was a low-profile bridge that fit in well aesthetically with its surroundings. Architectural elaborations included railings with orb finials, ornamental street lamps, and hip-roofed houses for the operators and public toilets.

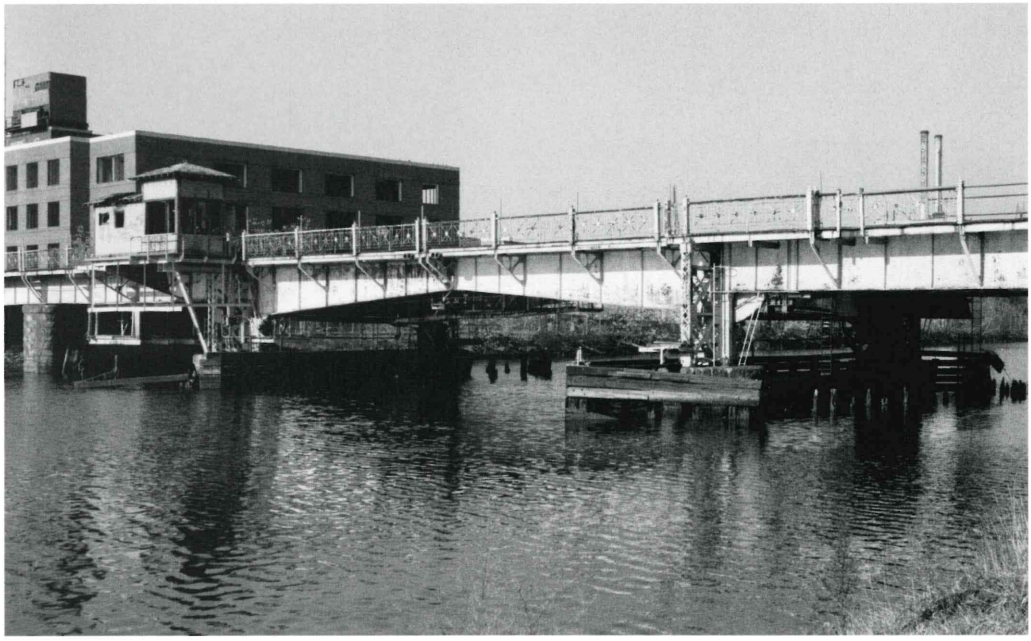
For more than 60 years the bridge served the community well, but eventually it became too unreliable and was closed in the 1990s. It was replaced by a modern bascule in 1998. Although the railing was upgraded, the original operator's house and toilet building was retained and repaired.

*Replacement bascule, 2002.*

# GRAND STREET BRIDGE (Bridge No. 4250)

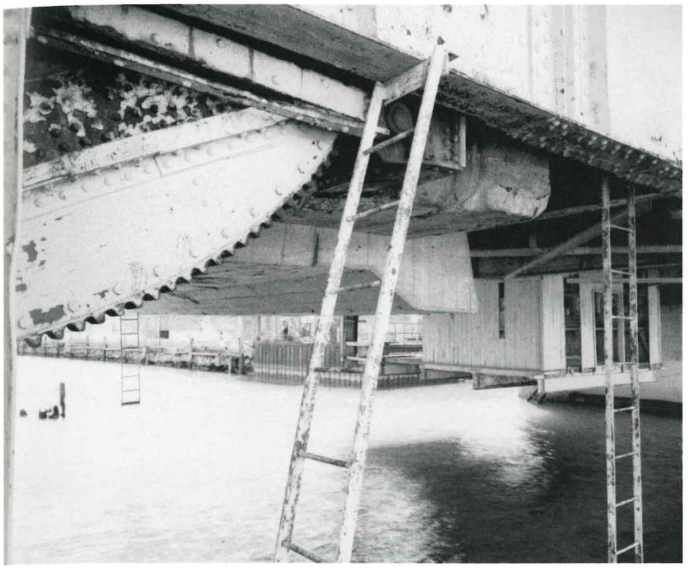
- Grand Street over the Pequonnock River
- Bridgeport
- Strauss underneath-counterweight deck-girder bascule
- Length: 5 spans, 372' overall, 91' double-leaf bascule
- Built in 1916-1919





*HAER photo, 1995, by Wayne Fleming.*

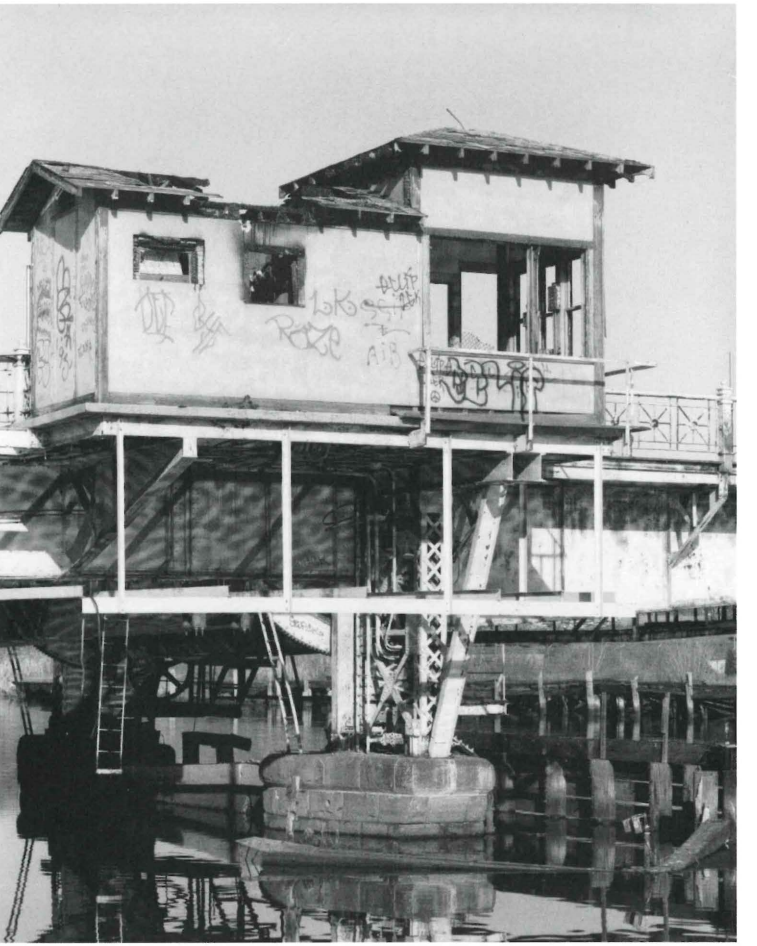
Grand Street Bridge was one of the three bascule projects undertaken by the City of Bridgeport to modernize its infrastructure during World War I. It was an especially important one, since Grand Street, on the west bank of the Pequonnock, bisected the enormous Bridgeport Brass Company, one of the leading munitions suppliers during the war, and so was important in allowing workers and materials to reach the plant. The city selected the Strauss Bascule Bridge Company of Chicago to design the bridge and Edward DeVoe Tompkins, Inc. of New York as contractor. Work began in 1916, and it soon became apparent that the city and the contractor could not get along. Each blamed the other (or the engineers) for delays, cost overruns, inadequate design (particularly for the pier foundations), and poor work. After spending a great deal of money, the city dismissed Tompkins and started over with another contractor. Shortages of steel also added to the delay, so the bridge, intended to serve war-time production, did not actually open until 1919, after the war had ended. In the end, the Tompkins company was vindicated in two ways: a lawsuit that went all the way to the Connecticut Supreme Court won for the company the full value of its contract, in effect making the city pay twice for the bridge. Then the bridge began to settle, requiring the city, this time with state assistance, to remove the bascule leaves, recon-



*Curved rack gear that operates the bascule, HAER photo, 1995, by Wayne Fleming.*

struct the entire substructure, and then reerect the movable portion of the bridge. Despite the huge and wasteful expenditure of public funds, the Grand Street Bridge proved to be an important asset during World War II, when Bridgeport's industrial sector once again went into high gear.

Like its near twin on East Washington Avenue, the Grand Street Bridge served Bridgeport's residents for many years, but eventually it also became too deteriorated to function. The bridge was closed in the 1990s and then removed. To date, no replacement has occurred.



*Operator's house, HAER photo, 1995, by Wayne Fleming.*

# YELLOW MILL BRIDGE (Bridge No. 3637)

- Stratford Avenue over the Yellow Mill Channel
- Bridgeport
- Fixed-trunnion deck-girder bascule
- Length: 6 spans, 562' overall, double-leaf bascule
- Built 1927-1929
- American Bridge Company, fabricator

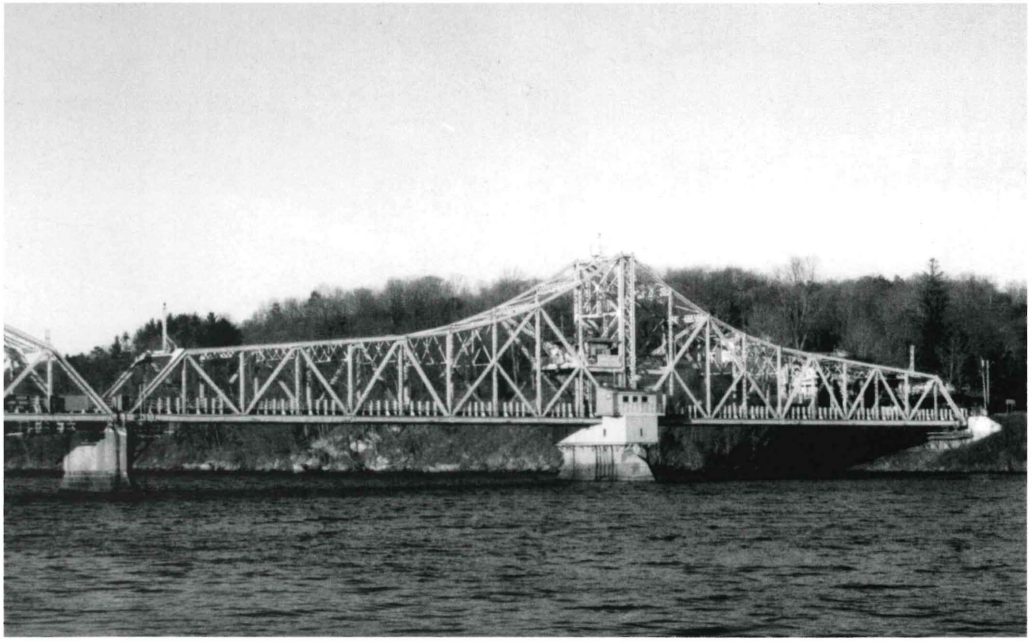
The Yellow Mill Channel was once one of Bridgeport's major industrial waterways. So-named because of a tide-powered gristmill that once stood near here, the channel was developed in the late 1890s to accommodate vessels serving the huge American Ordnance-Remington cartridge factory located on Boston Avenue at the north end. The project included a swing bridge to carry Stratford Avenue over the channel. Completed in 1903, the bridge was plagued by problems and required major work in 1906, 1914, and 1916. Not surprisingly, Stratford Avenue was included in the city's 1916 bond issue for three new movable bridges. Problems with the Grand Street Bridge forced Bridgeport to put the Yellow Mill project on hold and live with the old swing bridge until 1927, when the project was finally resuscitated. Once again, things did not go smoothly. The father of one of the bridge commissioners was discovered to be a secret investor in the construction firm building the bridge, and allegations of padded invoices caused a scandal. Whatever the cause, huge cost overruns occurred. State aid was proposed, but the only help the city received was $30,000 from the streetcar company, which ran its tracks over the bridge. Soon after it opened, the city had to undertake substantial repairs, including replacing the trunnion posts, this time assisted by a small state grant. Despite all the controversies, the city's investment in the

Yellow Mill Bridge proved vital during World War II, when Bridegport was once again called upon to supply vast amounts of munitions for America's war effort.

The bridge was designed by Edwin J. Beugler, a consulting engineer from New Haven. Although the ornamental street lights that adorned the bridge were replaced in the 1960s, its original architectural character can still be appreciated in the elaborately detailed brick operator and comfort-station houses, the Classical railings, and the arched form of the girders that make up both the approach spans and the bascule leaves.

## EAST HADDAM SWING BRIDGE (Bridge No. 1138)

- State Route 82 over the Connecticut River
- East Haddam - Haddam
- Warren through-truss swing bridge
- Length: 3 spans, 881' overall, 456' swing span
- Built in 1913
- American Bridge Company, fabricator





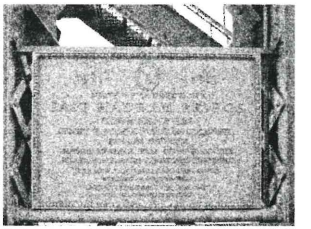
Built in response to vigorous lobbying by local residents and opened on Flag Day, 1913, this bridge was hailed as the embodiment of the "age of progressiveness." It was a large bridge for its day, creating a clearance of 200 feet on either side of the pivot pier, and it used up-to-date center-bearing technology and intricate moving wedge locks to position the bridge properly when closed. No other bridges crossed the Connecticut River between Middletown and Old Saybrook, so the bridge provided a real service to the southern valley region. It was a substantial and technically advanced project for its day and was written up in *Engineering Record*, a leading engineering periodical. Aside from the swing part, the 326-foot Pennsylvania-type fixed span ranked as one of the longest bridges in the state.

The engineer responsible for the design of this bridge was Alfred P. Boller, one of America's best-known bridge engineers. Boller had designed several large New York City drawbridges, as well as the 1889 railroad bridge across the Thames River at New London, and he was considered the nation's leading authority on deep bridge foundations. He died the year before the East Haddam bridge was completed.

In 1985 the state undertook a major rehabilitation of the bridge, including a new steel-grate deck, improvements to the operating machinery, and new guardrails.

*The fixed span on the west side of the river.*

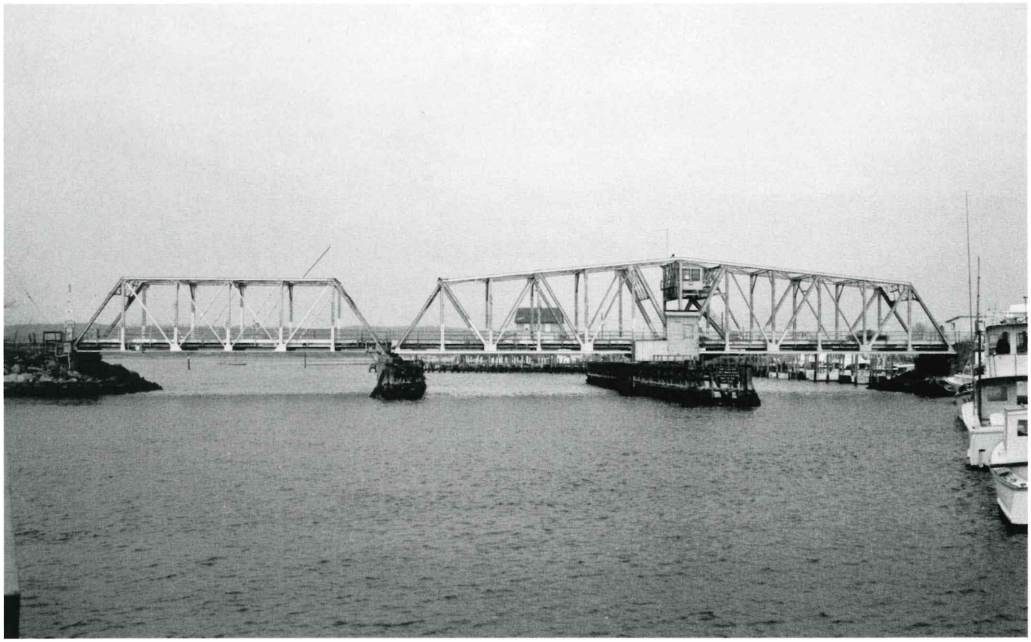
The biggest part of the project was a system of new diagonal eyebars inserted in between the existing eyebar pairs. This innovative approach to reinforcement allowed the weight rating of the bridge to be substantially increased, while preserving intact its original materials and the bridge's distinctive appearance.



# NIANTIC RIVER SWING BRIDGE (Bridge No. 1397)

- State Route 156 over the Niantic River
- East Lyme - Waterford
- Warren through-truss swing bridge
- Length: 2 spans, 283' overall, 180' swing span
- Built in 1921
- Berlin Construction Company, fabricator
- Replaced in 1991





*HAER photo, 1986, by Guy Freeman.*

This location has been an important part of the shoreline transportation network in Connecticut since colonial times. Ferry service at the Niantic River was established in the 1650s and continued through the better part of the 18th century; the boats were most likely propelled by the ferrymen pulling on a rope strung between the banks, a circumstance commemorated today in Waterford's name for Route 156, Rope Ferry Road. By 1796, the ferry had exhausted its capacity and the Niantic Bridge Company was chartered to construct and operate a toll bridge across the river. Not much is known about this bridge, except that it had a draw of some kind in order to allow passage for waterborne traffic traveling to and from the fisheries and quarries upstream. Later in the 19th century, Niantic began to emerge as both a seaside tourist attraction and a vacation spot for wealthy urbanites. As a result, the amount of pleasure-boat traffic increased, even as the demands for surface transportation were growing.

In 1917 the U. S. War Department, concerned that the coastal defense system was being jeopardized by the inadequate bridges along the Connecticut shore, ordered the State Highway Department to replace several bridges, including the one at Niantic. Ironically, another action by the federal government, the War Industries Board restrictions on the use of steel, prevented completion of the

*Replacement bridge, 2002.*



Niantic Swing Bridge until 1921, well after the fighting had ended.

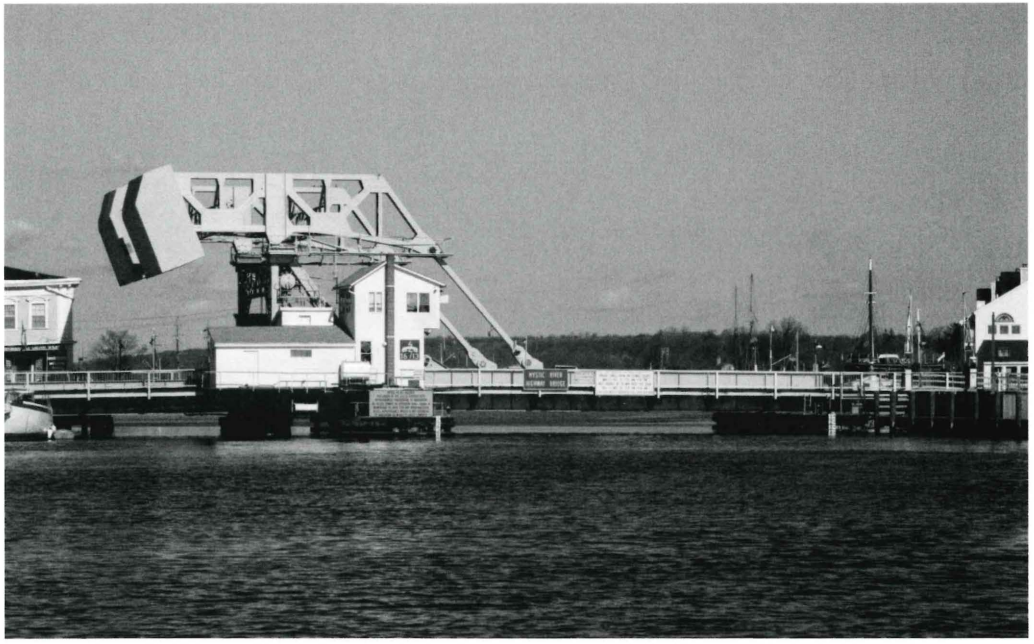
The bridge was a standard design for the times, differing from fixed highway bridges only in that the swing truss was made deeper in the middle so as to support itself when opening. The bridge was supported on a center bearing, with circumferential rollers serving only as guide wheels. The fabricator was the Berlin Construction Company (now known as Berlin Steel), founded in 1901 by former employees of the Berlin Iron Bridge Company, which had been absorbed into the American Bridge monopoly.

In 1991, prompted by a petition from workers at the Millstone nuclear power plant, the Department of Transportation chose to replace the Niantic River Swing Bridge. With its higher-level crossing, the new double-leaf bascule bridge does not need to open nearly as often as the bridge it replaced, allowing road traffic to flow much more smoothly.

# MYSTIC RIVER BRIDGE (Bridge No. 362)

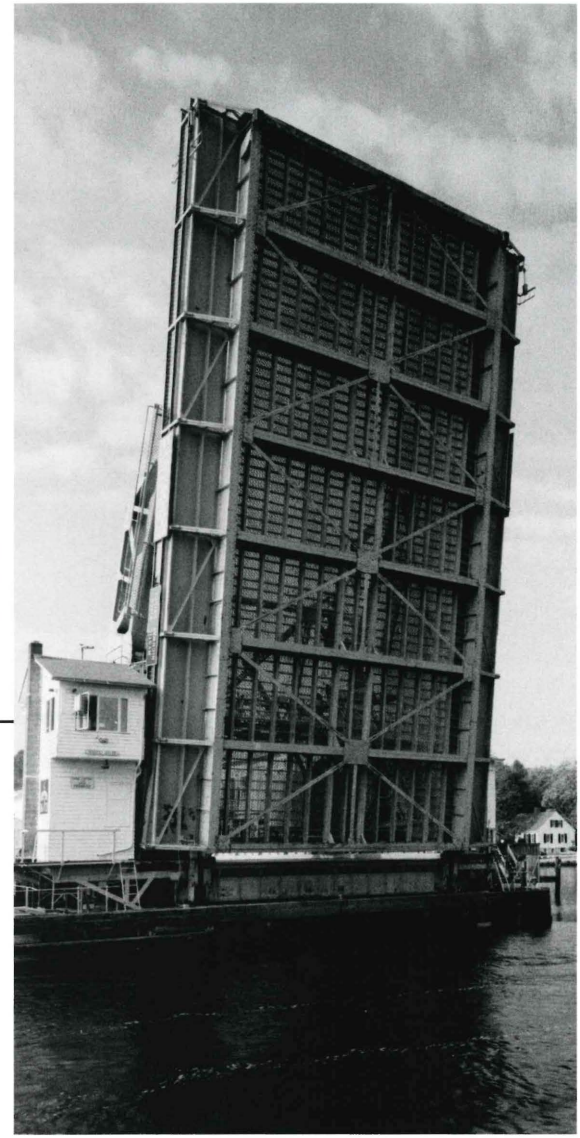
- U.S. Route 1 over the Mystic River
- Groton - Stonington
- Brown balance-beam through-girder bascule
- Length: 4 spans, 223' overall, 85' bascule
- Built in 1922
- American Bridge Company, fabricator





The Mystic River drawbridge, more than any other bridge in the state, demonstrates the mechanical genius that propelled movable-bridge innovation in the early 20th century. The rotating wheels that start the bridge moving, the descending overhead counterweights, and the huge linkage arms that tie the bascule girders to the counterweight beams all convince the observer that this is a machine as well as a structure. Its designer, Thomas E. Brown, had been chief engineer for the Otis Elevator Company. Later in life, he turned his attention to improving the operating mechanisms of movable bridges, winning both prizes and patents for his efforts. His design for the Mystic Bridge received a great deal of attention in the engineering periodicals and textbooks of the 1920s, though he died the same year the bridge was finished. Brown's bascule was regarded as exceptionally economical and practical. It required no toe locks because the weight of the girders and the inertia of the operating mechanism were sufficient to hold down the end of the bascule. The articulated linkage arms and unique operating wheels (termed "bull wheels" by Brown) provided stops for the bridge both at the top and bottom of the cycle, correcting for imprecise motor controls. The operating parts were easily accessible for maintenance and repair, and they were located well above the level of high tide. Finally, the counterweights were in a direct line with the towers and the bascule

*Detail of the counterweight linkage and bull wheel.*



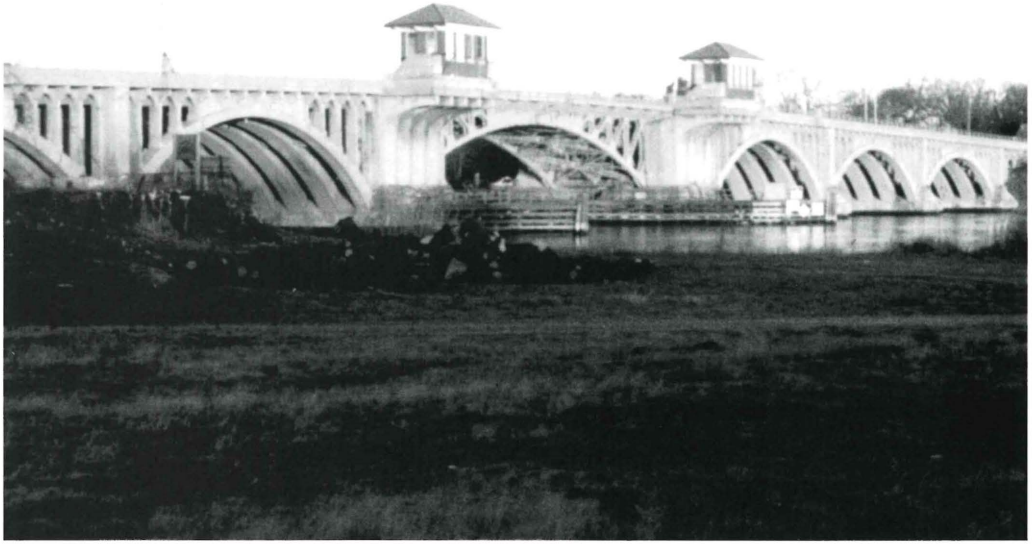


girders, minimizing any transverse stresses (because they rotate less than the bridge itself, the counterweights do not have to pass between the towers supporting the balance beam).

The Brown-designed bascule is at least the sixth drawbridge on the site. The first three were small wooden structures, then in 1866 came a cast and wrought-iron Truesdell-truss swing bridge, and then in 1904 a conventional steel through-truss swing bridge. The present bridge was built as part of the Connecticut Highway Department's early 20th-century effort to improve Route 1, the busy "Trunk Line" highway that served the Connecticut shoreline and acted as the major east-west route from Boston to New York. Completion of the Mystic River Bridge in 1922 was one of the final links in the program.

## WASHINGTON BRIDGE (Bridge No. 327)

- U.S. Route 1 over the Housatonic River
- Milford-Stratford
- Steel trunnion-bearing Brown bascule, open-spandrel concrete arches
- Length: 12 spans, 859' overall, 151' double-leaf bascule
- Bethlehem Steel Bridge Company, fabricator (bascule)
- Built in 1921





When the Connecticut Highway Department was given authority over major bridges in 1915, the department's engineers immediately turned their attention to U. S. Route 1, the state's busiest "Trunk Line" and a major route into New England from New York City. By its very nature as an east-west shoreline route, Route 1 continually crossed rivers and coastal inlets, thereby requiring numerous movable bridges. Planning for a bridge to replace ferry service across the Housatonic River began in 1915, but shortages of steel associated with World War I delayed completion until 1921. At the time, it was the department's most expensive bridge project ($1.5 million), and it was considered a showcase of the department's engineering expertise.

Most of the bridge was designed in-house by department engineers. Five of the fixed spans are 100-foot-long open-spandrel concrete arches. The open-spandrel design was used only for the largest and most important bridges because it was relatively difficult to design and build, requiring much more complicated forms for the ribs and uprights. However, it provided a tremendous savings in materials and reduced the overall weight of the bridge to a minimum. The open-spandrel design also gave the bridge an elegant appearance. The consultant for the movable portion of the bridge was John Alexander Low Waddell, the author of two influential technical books of

the period, *Bridge Engineering* and *Economics of Bridgework*. Waddell selected an undergrade counterweight design developed by Thomas E. Brown, who also designed the Mystic River Bridge (1922) on Route 1 between Groton and Stonington. The bascule leaves are arched so as to be aesthetically compatible with the open-spandrel fixed spans.

Two tile-roofed brick structures are cantilevered from the south side of the bridge; one is the operator's house and the other housed public restrooms but is now used for storage. In addition to the vehicular lanes and pedestrian sidewalks, the bridge originally accommodated two streetcar tracks (the reason the Connecticut Company, the operator of the area's trolley system, contributed part of the cost of construction). Today the bridge retains much of its historic appearance; the only major change is the modern tubular guardrail that supplements the arches' concrete parapet and replaces the bascule's original ornamental iron railing.

## CHAPEL STREET SWING BRIDGE (Bridge No. 3807)

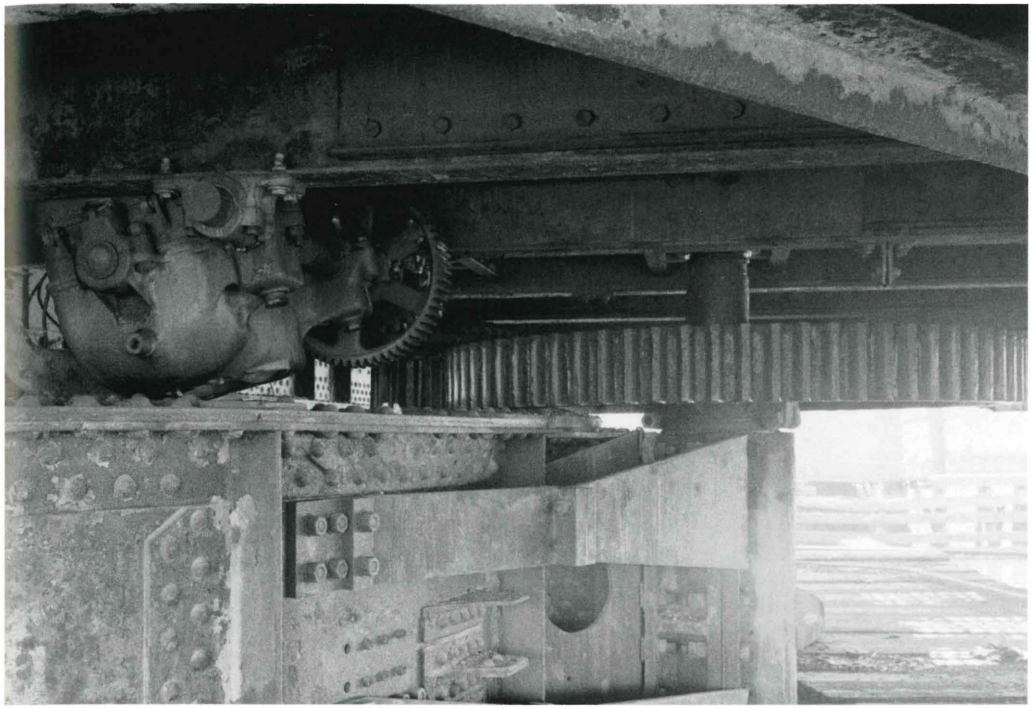
- Chapel Street over the Mill River
- New Haven
- Pratt through-truss swing bridge
- Length: 225' swing span
- Built in 1899
- Elmira Bridge Company, fabricator
- Replaced in 1992

*HAER photo, 1987, by Robert Moore.*

The Chapel Street Swing Bridge replaced a much smaller drawbridge built in 1869; instead of a single narrow movable section at the east end, the 1899 bridge provided nearly 100 feet of clearance on either side of the center pier. New Haven was a rapidly growing city at the time, particularly the Fair Haven section, and the new bridge better accommodated both pedestrian and vehicular needs and vessels serving industries along the Mill River channel. Like most 19th-century highway bridges, the major components were joined together by large pins. Pinned connections were preferred by many engineers because they were thought to transfer loads better and they made the bridge easier to assemble on-site. After 1900, advances in field riveting and appreciation for the greater rigidity of riveted connections began to make pinned bridges obsolete for most purposes.

The swing span consisted of two six-panel Pratt trusses joined together at the center of the bridge. The trusses were deeper at the center, resulting in an inclined top chord and creating an overall five-sided profile to the bridge, a shape that is sometimes referred to as "camelback." The bridge was of heavy box-girder construction, with eyebars for the diagonals, except in the two end panels, where girders were used to account for compressive forces when the bridge was closed.

The bridge's modern replacement is a deck-



*HAER photo, 1987, by Robert Moore.*

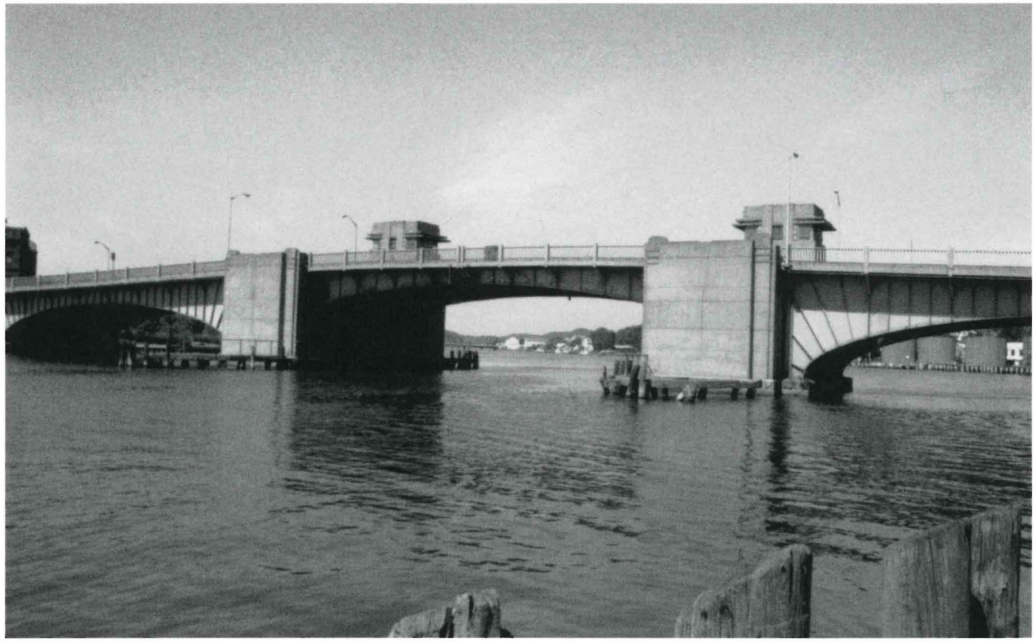
girder swing bridge, numbered Bridge No. 6169. The only resemblance to its predecessor is the placement of the control house above the roadway in the center of the bridge, an arrangement that gives the operators ample view of both the roadway and river traffic.

*Replacement bridge, 2002.*

# FERRY STREET BRIDGE (Bridge No. 3809)

- Ferry Street over the Quinnipiac River
- New Haven
- Heel-trunnion bascule
- Length: 3 spans, 431' overall, 101' double-leaf bascule
- Built in 1940
- Harris Structural Steel Company, fabricator





*HRC photo, 1991.*

Completed just before the United States entered World War II, New Haven's Ferry Street Bridge represents a melding of engineering with art and architecture. By 1940, the engineering profession had many years of experience with bascules, so technically the bridge breaks little new ground. What makes it special is its outstanding Art Deco detailing. The characteristics of the Art Deco genre include stylization, use of geometric motifs, and a futuristic appearance, all of which are evident in the Ferry Street Bridge. The Art Deco influence appears in the stepped corners and horizontal grooves (sometimes referred to as "speed lines") of the bridge's abutments and piers, as well as in the architecture of the two operator houses. The houses' stepped-back door frames are typical Art Deco elements, as is the vertical fluting in the parapets. The projecting flat roofs and metal industrial-type sash were regarded as very modern at the time. Further aesthetic touches include the arched form of both the approach and the bascule girders and the highly stylized lettering "Ferry Street Bridge 1940" superimposed on the New Haven city seal.

The bridge is also notable as a product of the federal Public Works Administration's program of building bridges and other work-relief projects throughout the nation. The Public Works Administration, part of the "New Deal" created by President Franklin D. Roosevelt during the Great

*HRC photo, 1991.*

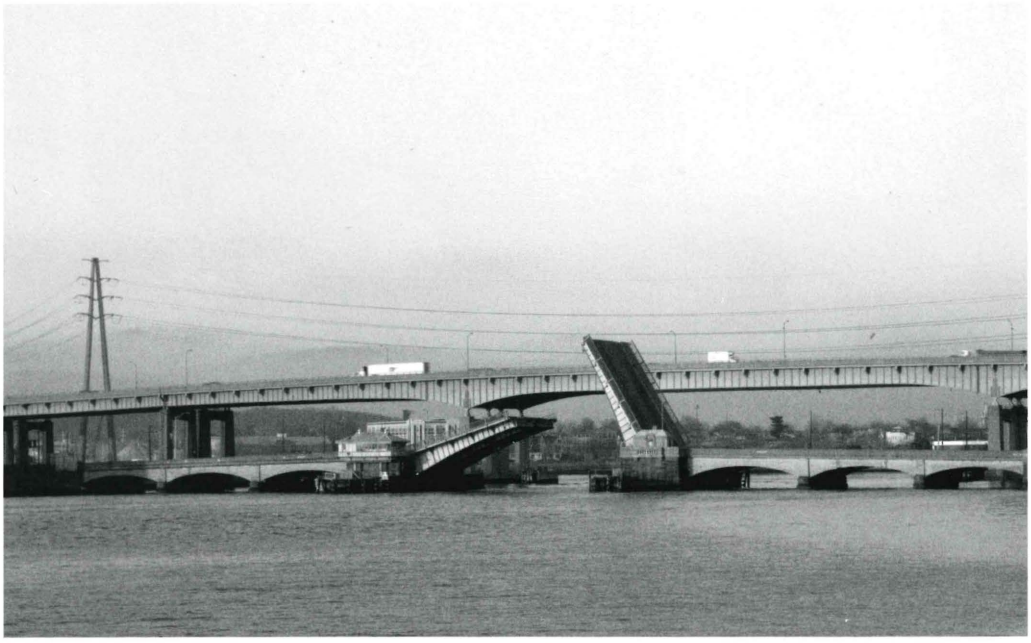
Depression of the 1930s, was intended to stimulate the economy and provide jobs for thousands of people desperate for work. The PWA contributed $337,000 of the bridge's total $803,000 construction cost. The overall design for the bridge was performed in-house by the city's engineering department, with the firm of Ash-Howard-Needles & Tammen serving as design consultant for the bascule.

*Detail of operator house (HRC photo 1991).*

# TOMLINSON BRIDGE (Bridge No. 337)

- Forbes Street (Route 1) over the Quinnipiac River
- New Haven
- Strauss heel-trunnion deck-girder bascule
- Length: 610' overall, 148' double-leaf bascule
- Built in 1924
- Phoenix Bridge Company, fabricator
- Replaced 1994-2002

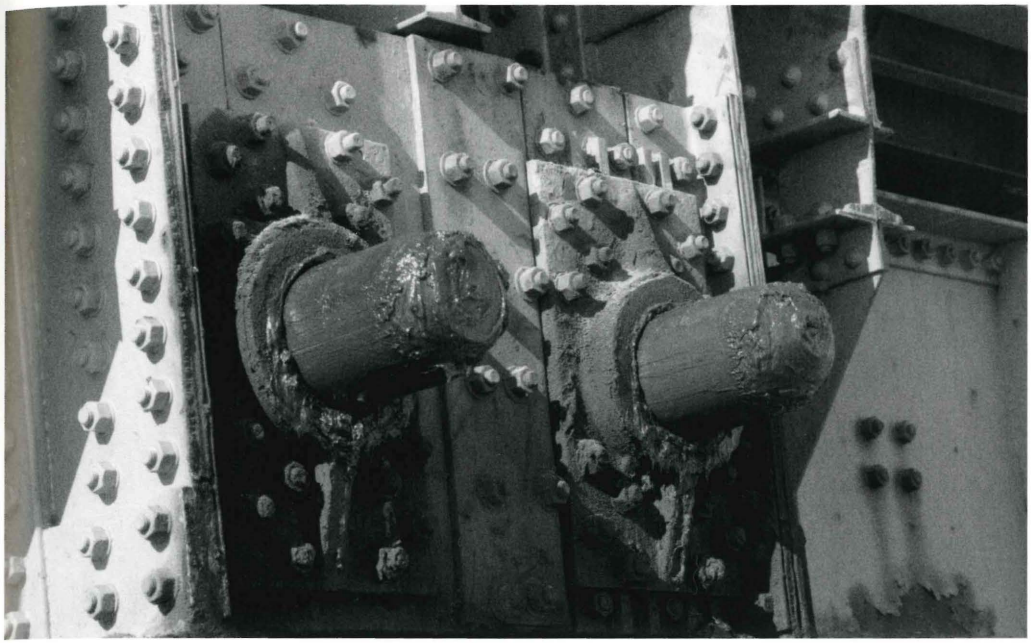




*HAER photo, 1996, by Robert Moore.*

This crossing has the distinction of being both one of the oldest places in Connecticut to have a drawbridge and also the site of the state's newest movable bridge. The first bridge was built in 1797 by a private company, headed by Isaac Tomlinson, and was operated as a toll bridge (tolls were initially expected to be deposited in a box on the honor system). It included a draw section so as not to impede navigation between New Haven Harbor and the Mill and Quinnipiac Rivers. The bridge was wholly or partly reconstructed in 1807 and 1842, and eventually the bridge company was acquired by the New York, New Haven & Hartford Railroad. In 1885, the state ordered the old wooden bridge to be replaced, so the railroad erected a new bridge using portions of the 1870 iron railroad drawbridge that had crossed the Housatonic River. The city bought out the bridge company in 1887.

By 1913, that bridge had become totally inadequate for the city's needs. It was narrow and had no sidewalks. Pedestrians competed with other traffic, which by that time included motor vehicles, streetcars, and the freight line of the Manufacturers Railway, a railroad that had been formed to serve east-side industries such as the Bigelow boiler factory. At the same time, water-borne traffic had increased to the point where the bridge was opening some 17,000 times a year.



*Detail of toe locks, which secure the bridge in the closed position (HAER photo, 1996, by Robert Moore).*

*Current bridge under construction, 2002.*



The Board of Aldermen authorized a bond issue in 1913 and planning for a new bridge began, overseen by local engineer Ernest W. Wiggin. Because of the war, the start of construction was delayed until 1922, but after two more years, the city finally had a modern bridge. The bridge that was to serve this location for the next 70 years was a double-leaf bascule that provided a clear width of 126 feet for the navigation channel. With a width of 61 feet, it provided plenty of capacity for sidewalks, vehicles, trolleys, and the railroad freight line, all the while offering faster openings and undoubtedly much more reliable operation. The Strauss design featured an undergrade counterweight, a characteristic that contributed to the aesthetic appearance of the bridge. Both the girder approach spans and the bascule leaves were arched in shape, creating a classical appearance. The theme was further carried out in the control houses, which were detailed in the Beaux-Arts style. The city paid more than $1.1 million for the bridge, so it is not surprising that it was given more than the usual amount of architectural detail.

The present bridge, begun in 1994, is even larger, providing a 240-foot navigation channel by means of a vertical-lift truss. Route 1 is four lanes wide at this point, and although there are no more streetcars to worry about, the bridge also carries the railroad freight line across the river.

# GRAND AVENUE SWING BRIDGE (Bridge No. 3810)

- Grand Avenue over the Quinnipiac River
- New Haven
- Pratt through-truss swing bridge
- Length: 315' overall, 205' swing span
- Built in 1896
- Berlin Iron Bridge Company, fabricator
- Replaced in 1984

*Original bridge, 1980 (Matthew Roth photo).*

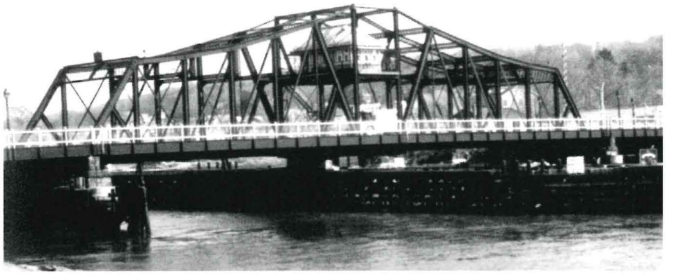


The Grand Avenue Swing Bridge was built for the City of New Haven in 1896 by the Berlin Iron Bridge Company, one of the largest bridge-building firms in the Northeast and the only one in Connecticut. As New Haven's industrialization continued in the 1890s, the navigable channels leading from the harbor were extended so as to provide better shipping access for industries. An earlier bridge on this site appears to have been a fixed span, and it did not have to be very long because there was a large island with a lumberyard on it taking up most of the width of the river. The new bridge provided about 80 feet of clearance on each side when it was swung open. It was of heavy box-girder construction and, as with most highway bridges of the late 19th century, it used large threaded pins to connect the major components, rather than gusset plates and rivets. The swing span consisted of two back-to-back Pratt trusses. The truss panels increased in depth toward the center of the bridge, creating a concave arc to the top chords. Like many movable bridges of the period, it carried street-railway traffic (two tracks) as well as pedestrians and motor vehicles.

The 1984 replacement is unique in Connecticut: it is a virtual reproduction of the old bridge using modern high-strength materials. The eyebar diagonals, lattice portal struts, and operator's house perched over the roadway in the center of the

bridge were all re-created, and it even has plaques over the portals like the old one, except, of course, the date "1984" and the other information refer to the new bridge.

*Highway and railroad bridges of all types were fabricated in the East Berlin shops of the Berlin Iron Bridge Company.*



*Replica, 2002.*

# SAUGATUCK RIVER SWING BRIDGE (Bridge No. 1349)

- State Route 136 over the Saugatuck River
- Westport
- Wrought-iron pin-connected Pratt through-truss swing bridge
- Length: 2 spans, 286' overall, 142' swing span
- Built in 1884
- Central Bridge Company (Union Bridge Company), fabricator

Connecticut's oldest remaining movable bridge was until recently exclusively hand-operated; many motor-driven bridges have a provision for hand-operation in an emergency, but this was the only one that had to be opened by hand. The operators would walk out to the center of the bridge, open a hatch, and insert a T-shaped bar with a socket on the end. The men would then walk in a circle, pushing the bar around, turning a pinion that engaged a fixed ring gear on the bridge's center pier. Slowly the bridge, which weighs more than 100 tons, swung open. The bridge mechanism was electrified in a recent rehabilitation project.

The present Saugatuck River Bridge was a replacement for a wooden drawbridge that had been built only fifteen years earlier. Wooden bridges typically did not last long. The strain of carrying traffic and of opening and closing weakened their already limited load capacity, and they deteriorated from rain, snow, and other assaults from the natural environment. In the case of the first Saugatuck bridge, marine borers attacked the bridge's timber piles, consigning it to an early demise. Not surprisingly, the town specified an iron bridge when it requested bids for a replacement. Metal trusses were one of the great engineering achievements of the late 19th century. Once the iron and steel industry had become established, iron bridges were actually less expensive

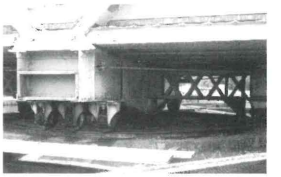
*The ends of the bridge hang out over the water as it swings open (HAER photo, 1990, by Robert Moore).*

*Workers closing the bridge, 1990 (HAER photo by Robert Moore).*



to erect. Moreover, they were far stronger and, if properly painted and maintained, could be expected to last a very long time.

The Saugatuck River Swing Bridge is a typical product of 1880s truss engineering, using pinned connections to join together the major components of both the 144-foot fixed truss and the 142-foot swing span. The firm that manufactured the bridge, the Central Bridge Company of Buffalo, New York, had a national reputation at the time. One of the company's principals, Charles H. Kellogg, had designed a swing bridge over the Mississippi River that was 444 feet long, a world record. He also developed an innovative method for forging eyebars, the long flat pieces of metal with large holes in the ends that are used for the diagonals of the Saugatuck bridge and most other pin-connected trusses. Kellogg's own bridge company was absorbed in 1881 by the Central Bridge Company, which in turn was taken over by the Union Bridge Company just as the Saugatuck Bridge was being built. Union Bridge lasted until 1900, when it became part of the American Bridge Company.



*Bearing detail, 1990 (HAER photo by Robert Moore).*

# MOVABLE RAILROAD BRIDGES

Railroads built most of the state's earliest metal-truss movable bridges, beginning around 1850, though only relocated fragments of these early structures survive (see entries for the Middletown Railroad Bridge and the Housatonic River Railroad Bridge between Milford and Stratford). For the most part, the state's movable railroad bridges date from the first 20 years of the 20th century, a period when railroads were relatively prosperous and had both the motive and the means to upgrade their facilities. In the 1890s, the New Haven Railroad's main line between New Haven and New York City was enlarged from a double-track line to four tracks, and in the following decade it was electrified so as to provide speedy, high-volume service along America's busiest passenger corridor. New bridges were built at all the major river crossings. The earliest surviving bridge, the 1896 Mianus River Bridge in Cos Cob, Greenwich, is a swing bridge, but the others are bascules. Another reason for rebuilding bridges in this period was the increased load created by ever-larger steam engines. In fact, early 20th-century steam engines and their heavily loaded tenders greatly exceeded the weight posed by modern trains, which consist of lightweight passenger cars pulled by smaller electric or diesel engines.

Railroad traffic posed special problems for the designers of movable bridges. The heavy engines and cars not only posed more of a load than highway bridges, but also caused substantially more vibration. Moreover, properly aligning the bridge after closing it was much more critical, since the ends of the rails had to come together exactly. Many of the state's railroad bridges also had to maintain the continuity of the overhead electrification. Finally, railroad bridges required more in the way of signalization, interlocks, and other safety considerations, because trains cannot stop quickly enough to avoid an open bridge.

Unlike highway bridges, high-level crossings are not much of an option for rail lines because trains cannot easily climb more than about a 2% grade. (One high-level railroad crossing, New York City's Hellgate Bridge, requires miles of ramped trestles to achieve the necessary elevation). As a result, more of the state's railroad bridges have required substantial rebuilding or replacement.

◂ *Niantic River Railroad Bridge, East Lyme.*

# PEQUONNOCK RIVER RAILROAD BRIDGE (Bridge No. 8064R)

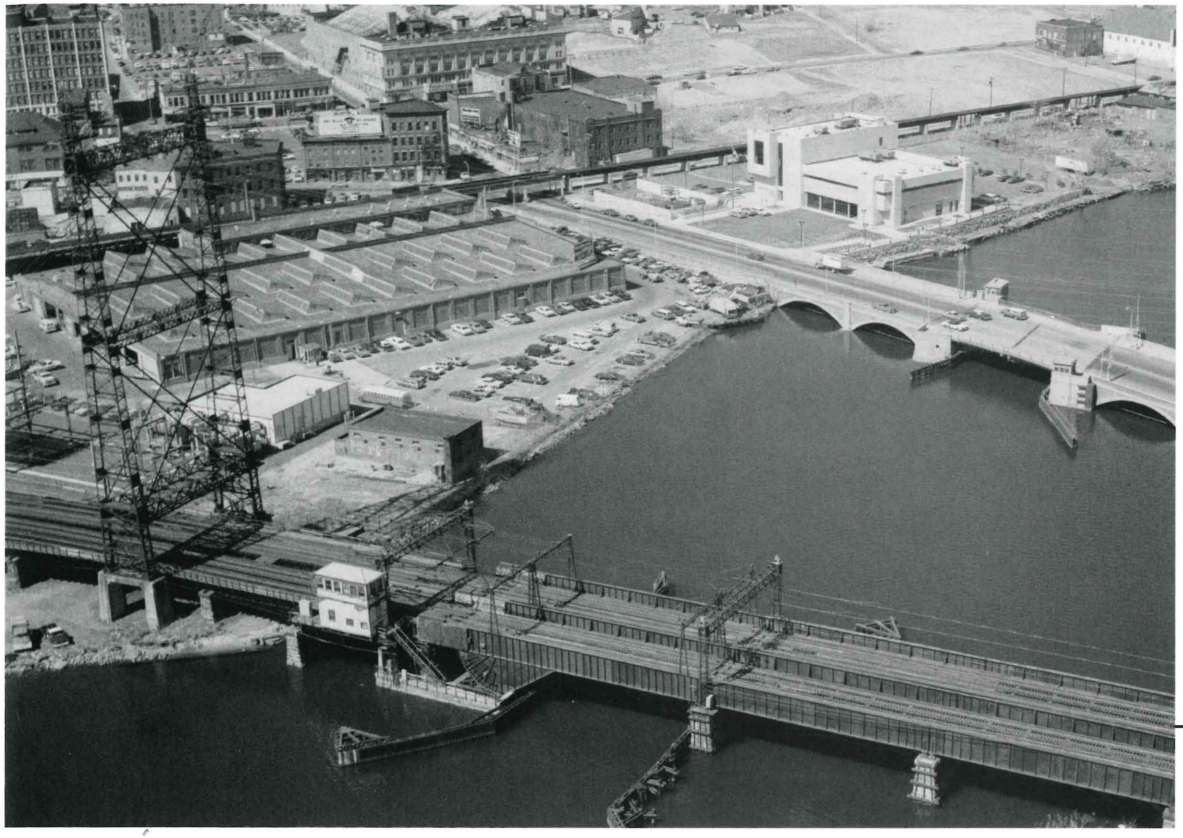
- Metro-North Railroad over the Pequonnock River
- Bridgeport
- Through-girder Scherzer rolling-lift bascule
- Length: 4 spans, 359' overall, 126' bascule
- Built in 1902
- Pennsylvania Steel Company, fabricator
- Replaced in 1996

*HRC photo, 1996.*

Bridgeport's Pequonnock River Bridge was one of the first bascules built by the New York, New Haven and Hartford Railroad (commonly called the New Haven). Pioneered in the 1890s in Chicago (like Bridgeport, a heavily industrialized city with numerous navigation channels), bascules were quickly adopted by railroads throughout the country because they opened and closed faster than swing bridges. The bascule portion of this bridge was close to the upper limit of what could be accomplished with the girder configuration; all longer shoreline bascules of this period are through-trusses. Girders were simpler to construct and put in place compared to trusses, but there was a practical limit to how long they could be made, beyond which trusses became more practical.

The 1902 bridge had two parallel two-track bascules, each capable of independent operation. The bascules were electrically powered, with the leaves rolling back on huge rounded girders; a counterweight attached to the heel of the bridge dropped into a pit as the bridge went up. The line was electrified in 1907, at which time overhead supports for the catenary were installed. The operator's house was at the east end of the bridge. The piers were of stone construction.

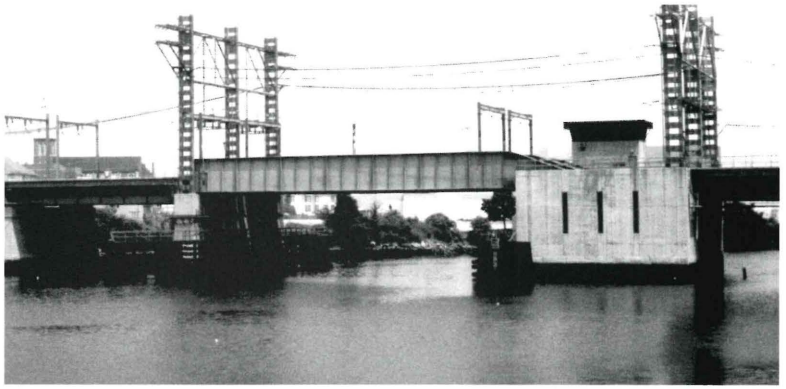
The bridge's replacement consists of welded through-girder bascule leaves,



*Aerial view of Pequonnock River Railroad Bridge, Congress Street Bridge in background (HAER photo, 1977, by Jack E. Boucher).*



concrete piers, steel-beam approach spans, and a block-like concrete substructure that contains the operating mechanism and counterweights.



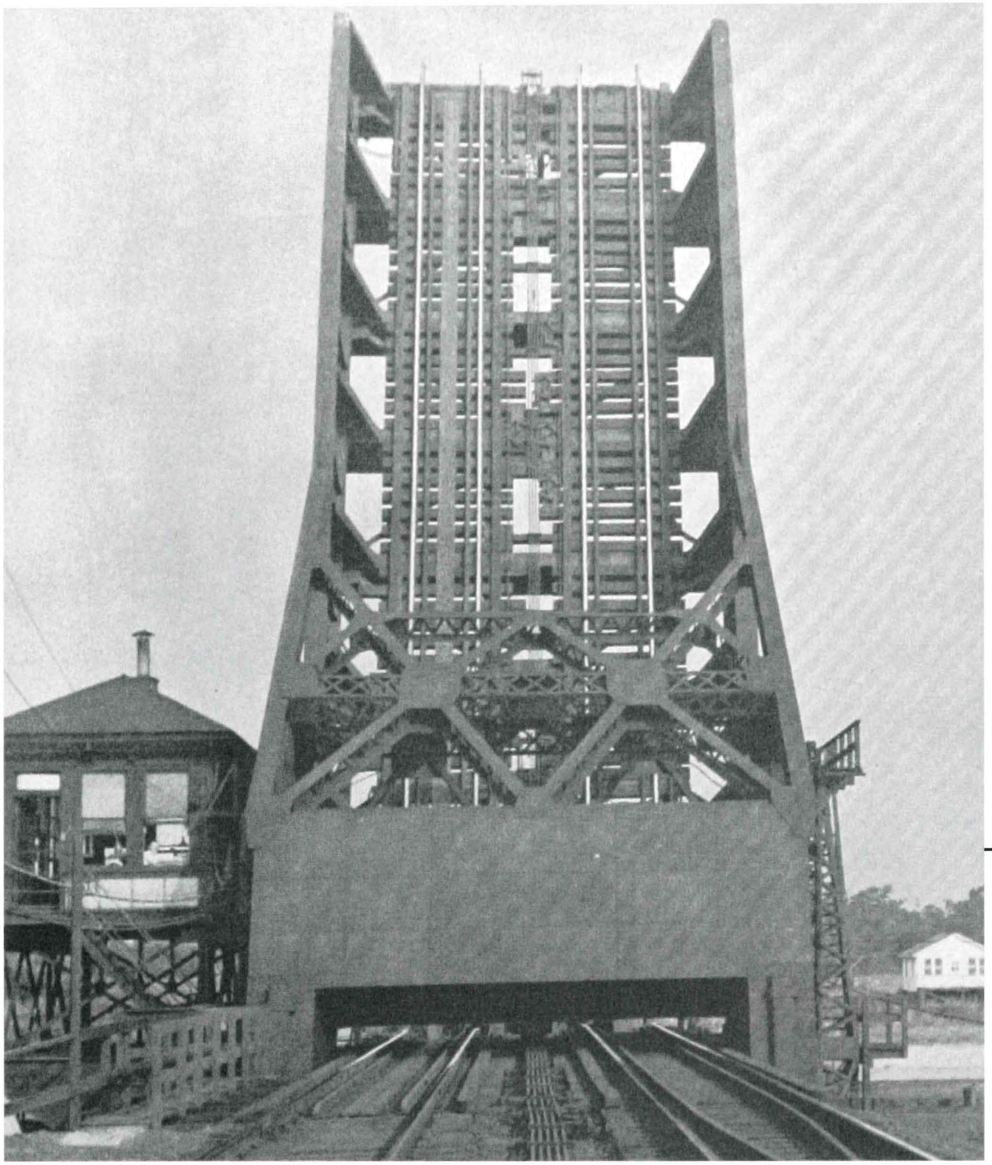
*Replacement bridge, 2002.*

# NIANTIC RIVER RAILROAD BRIDGE

- Amtrak over the Niantic River
- East Lyme - Waterford
- Through-girder Scherzer rolling-lift bascule
- Length: 5 spans, 294' overall, 70' bascule
- Built in 1907
- King Bridge Company, fabricator

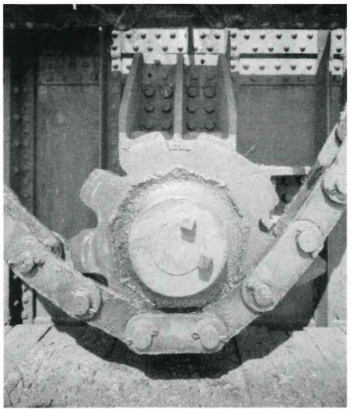
The New York, New Haven and Hartford Railroad built numerous bascules along the Connecticut shore in the early 20th century, as it sought to upgrade the capacity of its main line to accommodate higher speeds, more traffic, and the ever-increasing weight of steam locomotives. Although similar, each bridge has some unique characteristics. In the case of the Niantic River crossing, it is the operating mechanism that is unusual: the bridge is the only chain-driven bascule on Amtrak's Northeast Corridor. Instead of the bevel and rack-and-pinion gearing used to operate most bascules, the bridge is driven by huge chains on either side that cause the curved segmental girders to roll back on their tracks, thereby raising the bridge. The chains are powered by large sprockets on the shafts of the drive motors, which are below the level of the tracks.

The bridge replaced an earlier swing bridge on the site; the masonry pivot pier for the swing bridge remains just south of the bascule. In the 1990s, Amtrak electrified the line between New Haven and Boston, resulting in the addition of overhead catenary supports. The railroad recently announced its intention to replace the bridge.



*Engineer's view of the open drawbridge, from* **Along the Line,** *New Haven Railroad employee magazine, 1946.*



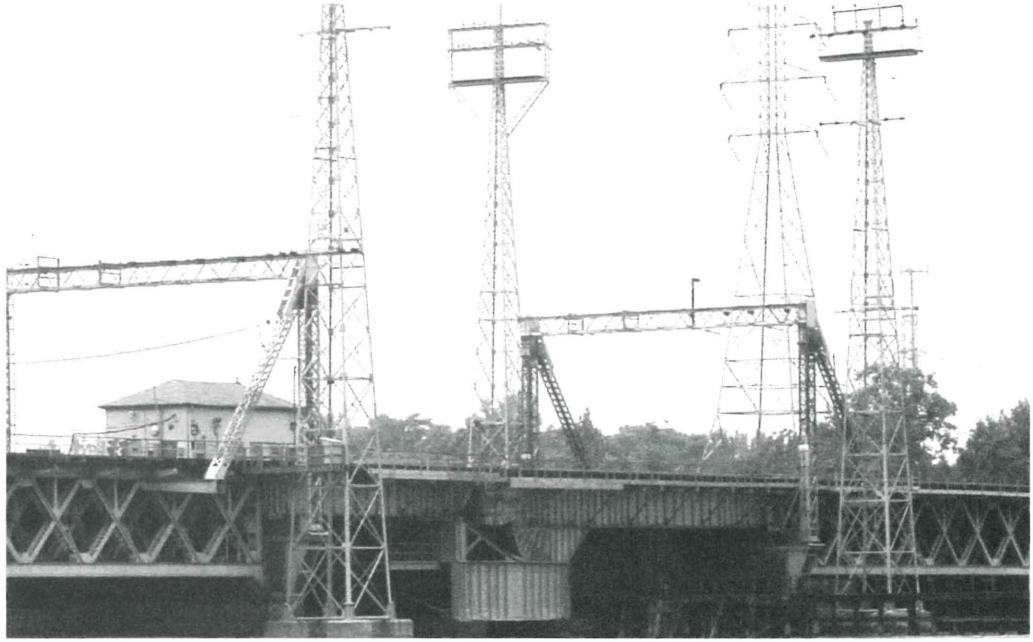


*Detail of chain drive, HAER photo, 1978, by William Barrett.*

# MIANUS RIVER RAILROAD BRIDGE (Bridge No. 8008R)

- Metro-North Railroad over the Mianus River
- Greenwich
- Deck-girder Scherzer rolling-lift bascule
- Length: 11 spans, 1,059' overall, 107' bascule
- Built in 1904
- American Bridge Company, fabricator



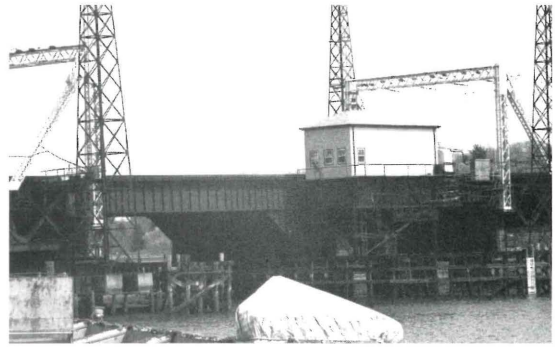


As with most of the movable bridges between New York and New Haven, the Mianus River Bridge, also known as the Cos Cob Bridge, utilizes two parallel bascules, each carrying two tracks. Each bascule is an independently operated Scherzer rolling-lift. One of the major innovations in movable-bridge design, the Scherzer bascule actually rolls away from the navigation channel as it lifts, supported on huge curved girders that mesh with stationary tracks atop the adjacent deck-girder span. The bascules are balanced by counterweights attached to the heel. The counterweights, electric motors, and drive mechanisms are not readily visible because they lie below the level of the tracks.

The bascules are of the deck-girder type. Deck girders were easier to fabricate and erect, and they provided unlimited horizontal and vertical clearance for passing trains; they were practical for spans of about 100 feet or less. (Within two or three years of the shoreline bridges' construction, the New Haven Railroad's pioneering electrification, with its catenary towers and overhead wires, took away any clearance advantage.)

The current deck-truss approach spans probably date from an earlier 1890s swing bridge. Double-intersection Warren-type trusses, they closely resemble the trusses in the 1896 Norwalk River railroad swing bridge just a few miles up the line.

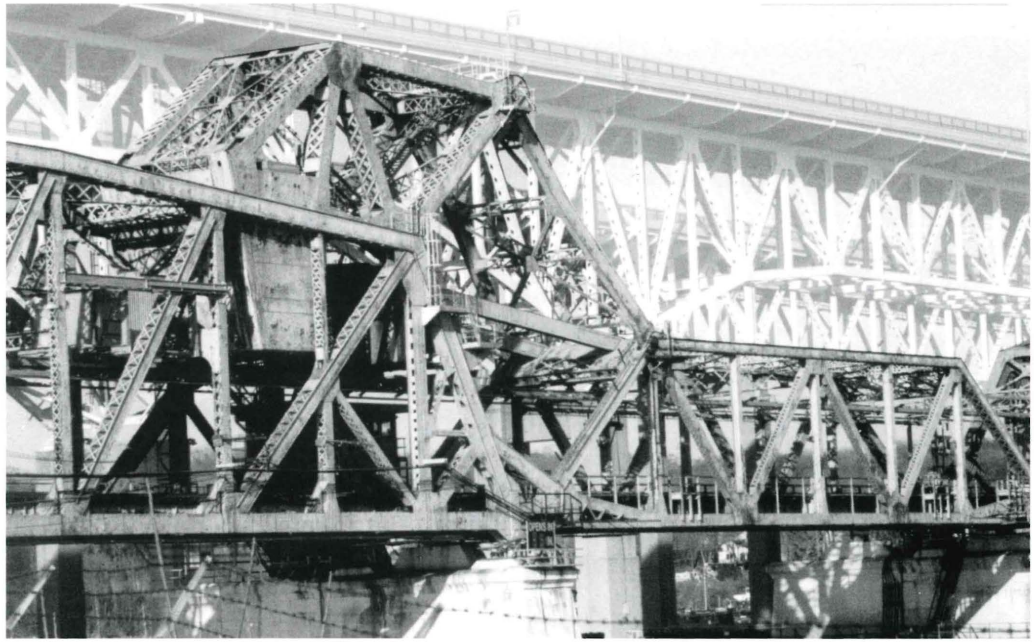
*Aerial view, HAER photo, 1977, by Jack E. Boucher.*



*HRC photo, 1986.*

# THAMES RIVER RAILROAD BRIDGE

- Amtrak over the Thames River
- Groton - New London
- Strauss heel-trunnion Warren through-truss bascule
- Length: 5 spans, 1,389' overall, 188' bascule
- Built in 1918
- American Bridge Company, fabricator





The Thames River Railroad Bridge has the longest span of any bascule in Connecticut, reflecting the size and importance of the navigation channel it serves. For more than 100 years the United States has operated a facility just upriver on the Groton side, now in use as a major submarine base. This was a difficult bridge to build because of the depth of sediment in the river. The footings for the piers were sunk by means of pneumatic caissons and extend some 80' into the river bed, making them very expensive to build. Although the bridge is only two tracks in width, the piers and abutments were made wide enough for four tracks so that if widening of the line became necessary, the railroad would not have to incur again the expense of sinking foundations in the Thames River.

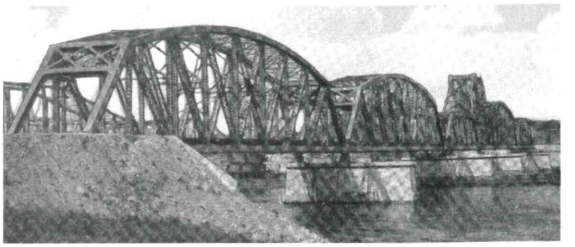
The earlier bridge at this site was itself something of an engineering triumph when completed in 1889, though ultimately it was not a success. It eliminated the last gap in the shoreline rail route between Boston and New York; no longer would trains have to be carried across the river in large ferry boats. Designed by noted engineer Alfred Boller, the first Thames River Bridge was the largest double-track drawbridge in the world, providing a clear channel of 225' on each side of the center pier. Almost immediately after completion, however, the piers began to settle, and in 1905 load restrictions went into effect, preventing the railroad's larger steam engines from

*HAER photo, 1978, by William Barrett.*

using it. By 1908, only one of the two tracks was serviceable.

The current bridge's Strauss heel-trunnion design uses a rocking-beam counterweight that rotates on its own support at the east end of the adjacent approach span. The counterweight is connected by long struts to the top and bottom corners of the moving span, which pivots on its heel trunnion as the counterweight descends. The bridge is put into motion by means of operating struts that are connected to the upper corners of the moving span. The operating struts have rack gears that engage pinions powered by the electric drive motors. Unlike a Scherzer rolling-lift bascule, the Strauss design keeps lateral forces on the piers to a minimum. Instead, the parallelogram of struts between the bascule and counterweight structure folds up, creating an almost perfectly vertical thrust at the pier. Given the unhappy history of the predecessor's piers, this attribute of the Strauss design was undoubtedly a major reason for its selection.

At the time of writing, the Thames River Railroad Bridge is still in service. Amtrak, however, has announced its intention to replace the bridge.



*Postcard view of the new bridge from the Groton side, with the old bridge visible on the left.*

# MYSTIC RIVER RAILROAD BRIDGE

- Amtrak over the Mystic River
- Groton - Stonington
- Through-truss swing bridge
- Length: 277' overall, 181' swing span
- Built in 1919
- American Bridge Company, fabricator
- Replaced in 1984

*HAER photo, 1978, by William Barrett.*

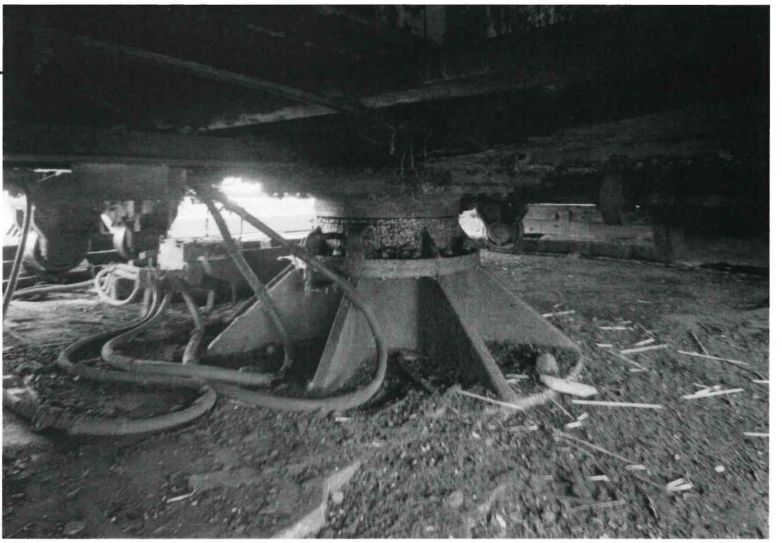
The rail bridge that formerly spanned the Mystic River between Groton and Stonington was a center-bearing through-truss swing bridge constructed in 1919. The nine-panel truss was of the Warren pattern, with verticals extending from the apexes of the triangles. A small operator's house was perched on top of the bridge at the center, though actual operating controls were in another house on land on the north side. There were two 25hp motors, one for opening the bridge and the other for operating the wedges and locks that held the bridge in place when closed. The 1919 bridge reused the circular stone center pier and timber-trestle approaches of an earlier drawbridge (1892) on the site.

In the early 20th century, center-bearing bridges had almost completely replaced the earlier rim-bearing type. Although the 1919 Mystic River Bridge had circumferential rollers to steady the bridge, most of the actual load as it operated was carried by a single bearing at the pivot point. Assuming the bridge was well-balanced and reasonably rigid, the single center bearing allowed for smoother operation. However, the bearings needed for center-bearing bridges had to be of very high capacity and typically utilized special metals such as phosphor bronze. When closed, both the ends and the center of the bridge were locked in place atop wedges, relieving the bearing from carrying any stresses.

The current Mystic

*Replacement bridge.*

River Railroad Bridge is a modern replacement intended to replicate the appearance of its 1919 predecessor. It too is a Warren-type through-truss, though built with I-beam members rather than box girders and with larger gusset plates connecting the various parts. Because the approach trestles have been eliminated, the bridge is 12 panels long, for a span length of 263'. The controls are in an operator's house supported on the top chords at the center of the bridge.



*Detail of center bearing, (HAER photo, 1978, by William Barrett).*

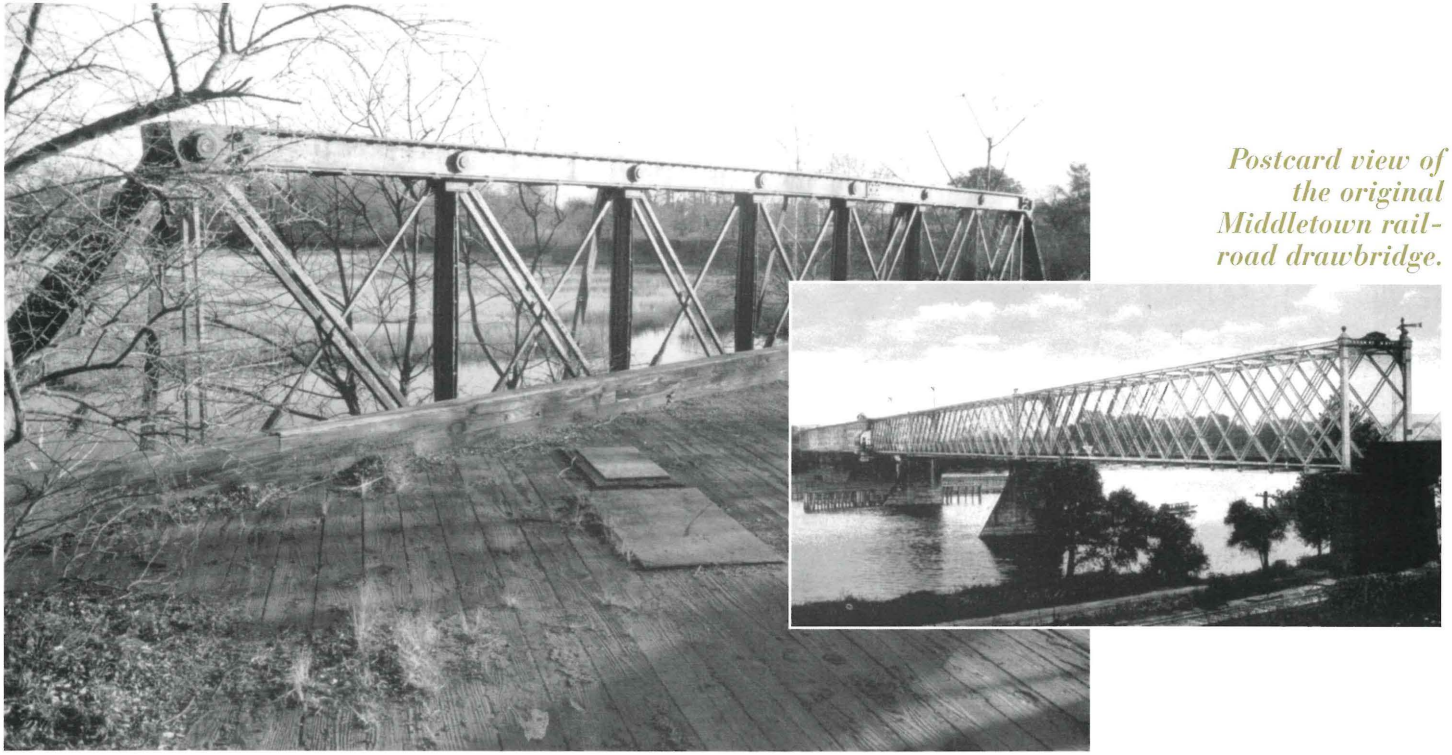
# MIDDLETOWN RAILROAD BRIDGE (Bridge No. 9016R)

- Former Air Line rail line over the Connecticut River
- Middletown - Portland
- Warren through-truss swing bridge
- Length: 6 spans, 1,142' overall, 300' swing span
- Built in 1911
- American Bridge Company, fabricator

Because of its rusty appearance and the fact that it is nearly always open, many people think that this railroad swing bridge across the Connecticut River at Middletown is no longer operational, but if one is there at the right time nearly any day, one can watch the crew of the Providence and Worcester Railroad close the bridge and proceed over it to deliver freight cars to the Portland side. For such a large structure, it is remarkably quiet in operation, the hum of its electric motor difficult to hear over the train's idling diesels.

As in most swing bridges, the operating span actually consists of two trusses joined together over the pivot; the trusses are deeper in the center, creating a five-sided top chord to the movable part. The bridge has subdiagonals running from the midpoint of the principal diagonals and a full set of vertical members; these elements help to stiffen the bridge and provide intermediate supports for the deck structure. There is an operator's house, no longer in use, high above the tracks in the center of the bridge and a smaller control building cantilevered from the south side of the approach span adjacent to the west end of the swing part. The approaches include four large double-intersection Warren through-trusses and a smaller girder span that carries the tracks over State Route 9.

The single-track line carried by the bridge was originally part of the Air Line Railroad,



*Postcard view of the original Middletown railroad drawbridge.*

*Pine Creek Bridge, Fairfield, a remnant of the original Middletown railroad drawbridge.*

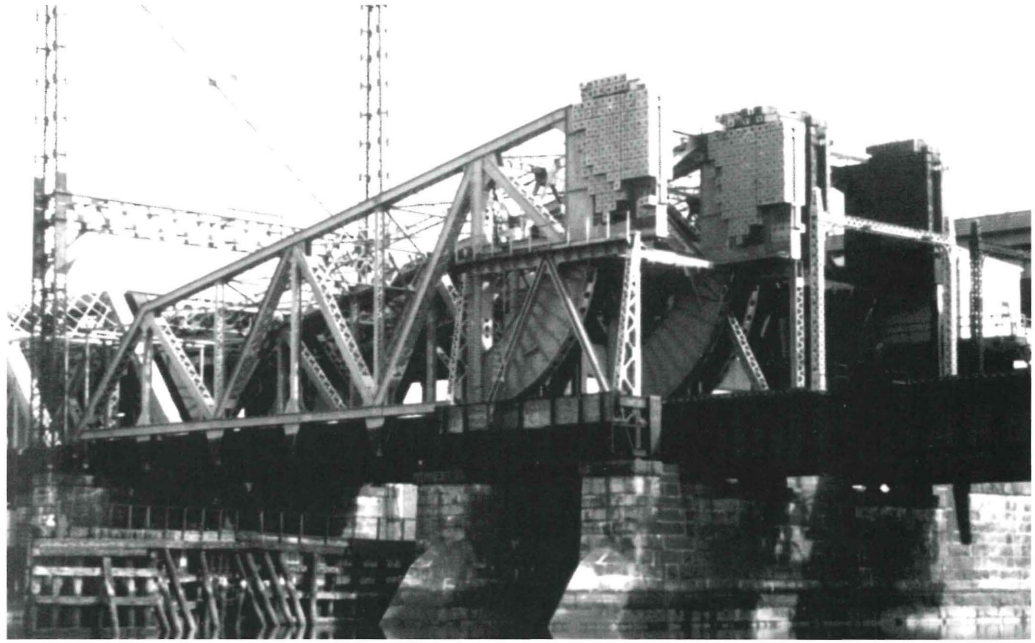


so-called because it most nearly represented a straight-line route between Boston and New York. In Connecticut the line connected New Haven, Middletown, Willimantic, and Putnam. Maritime interests and Hartford businessmen opposed the railroad, claiming that another bridge over the Connecticut River would impede navigation.

Nevertheless, the railroad received permission to bridge the river in 1872 and constructed the current bridge's predecessor. Although they were motivated mostly by the fear that business in Hartford would be hurt if Middletown became more of a rail center, the opponents to the bridge saw their predictions come true in 1876 when the passenger steamer *City of Hartford* rammed into one of the approach spans, causing it to collapse on its deck. The bridge was quickly repaired and put back in service (a remnant of that earlier bridge survives today in Pine Creek Park in Fairfield). In 1882 the line was leased to the New York, New Haven and Hartford Railroad and acquired outright in 1907. The New Haven undertook a series of improvements to the line, including filling in the Lyman and Rapallo viaducts and building the current drawbridge. Today rail service on the former Air Line ends at the Portland industrial area.

# HOUSATONIC RIVER RAILROAD BRIDGE (Bridge No. 8080R)

- Metro-North Railroad over the Housatonic River
- Milford - Stratford
- Warren through-truss Scherzer rolling-lift bascule
- Length: 7 spans, 1,052' overall, 110' bascule
- Built in 1905
- American Bridge Company, fabricator





The Metro-North railroad bridge across the Housatonic River lies in the shadow of Interstate 95, a high-level highway crossing just to the south, and it is probably missed by most of the motorists traveling on that busy road. From ground level, however, the bridge appears as a magnificent work of engineering, one that is particularly expressive of the mechanical nature of movable bridges. Unlike many of the state's bascules where the counterweights are hidden, in this bridge the counterweights are mounted at the upper corners above the level of the tracks, and the huge segmental girders on which the bridge rolls back are also readily visible. When this bridge opens, there is no mystery as to how it works.

The moving portion of the bridge consists of two parallel Warren through-trusses, each of which carries two tracks. The drive mechanisms, including the electric motors that power the bridge, are located on platforms between the upper chords of each truss. The navigation channel is 100 feet wide, too big to be bridged by the single-leaf deck bascules used at other points on the railroad, so the railroad's designers chose a through-truss for this bridge. Four of the approach spans are themselves substantial bridges, Baltimore-type through-trusses of heavy box-girder construction. The Housatonic River is very wide at this point, necessitating a substantial system of approaches.

*Riverside Avenue Bridge, Greenwich, a remnant of the original Housatonic River railroad drawbridge.*



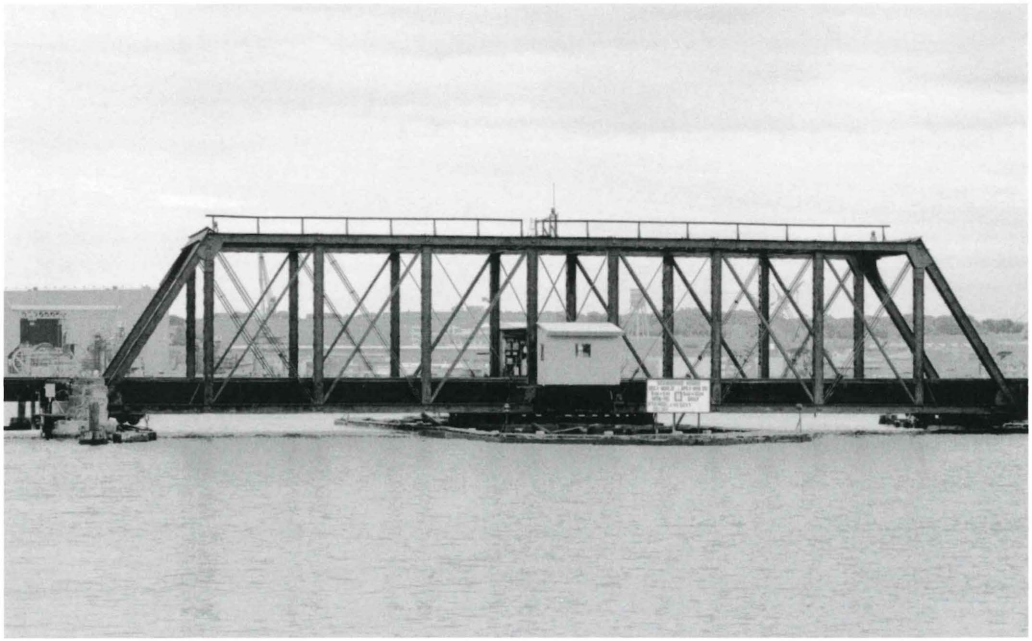
The first railroad bridge at this site was a wrought- and cast-iron swing bridge built in 1871 by the Keystone Bridge Company. An approach span from the earlier bridge, which was designed by noted engineer Francis C. Lowthorp, was re-used by the railroad to carry Riverside Avenue over the tracks in Greenwich; rehabilitated in 1989, it remains in service today.

Because the east end is in the Devon section of Milford, the structure is also known as the Devon Bridge. At this point the Shoreline route is joined by a north-south rail line leading up the Naugatuck River Valley to Waterbury.

# SHAW'S COVE RAILROAD BRIDGE

- Amtrak across channel to Shaw's Cove
- New London
- Rim-bearing pin-connected Pratt through-truss swing bridge
- Length: 136' swing span
- Built in 1891
- Berlin Iron Bridge Company, fabricator
- Replaced in 1984

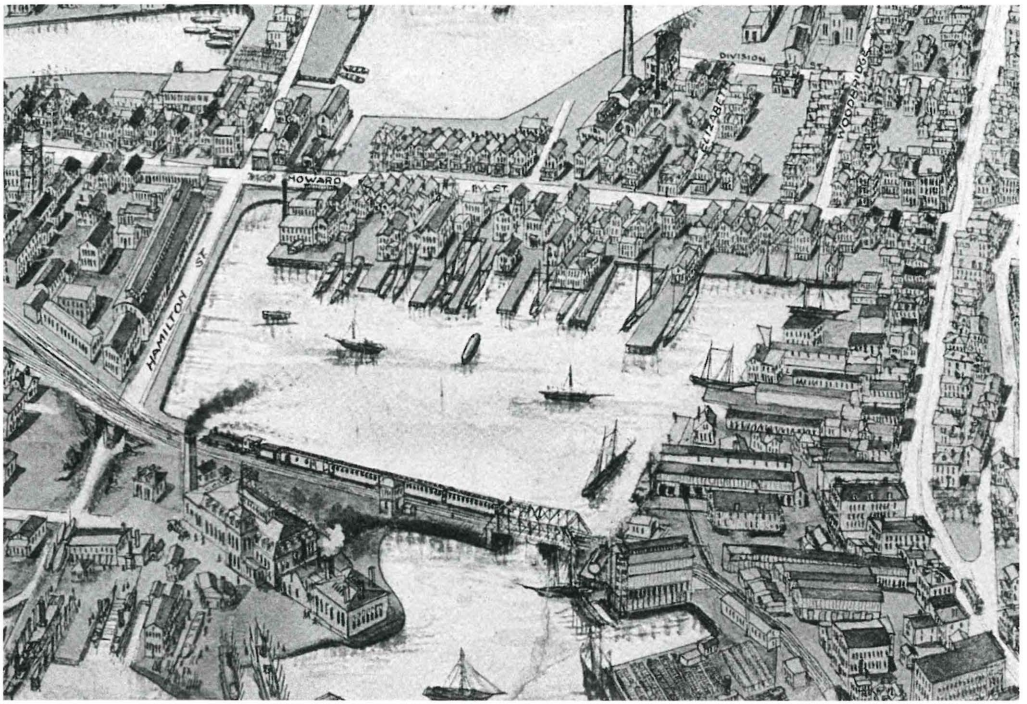




*HAER photo, 1978, by William Barrett.*

The Shaw's Cove swing bridge was built in 1891, shortly after the New Haven Railroad also completed the first drawbridge across the Thames River. The Shaw's Cove Bridge was a rim-bearing swing bridge, in which the weight of the rotating span was carried on large rollers that ran in a track atop the circular pier. Later swing bridges carried the weight on the center pivot, but this development depended upon the perfection of high-capacity bearings, such as those made with phosphor bronze. The bridge itself was designed as a pin-connected truss, in which the principal members were joined with large threaded pins held in place by nuts. By 1900, this characteristic was also in decline, as engineers came to prefer trusses that had their members riveted together using large gusset plates at the connections. Riveted trusses were more rigid than pin-connected trusses, a consideration that was especially important in railroad bridges.

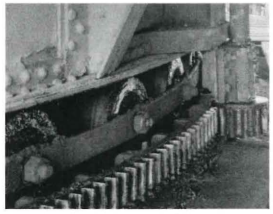
The fabricator of this bridge, the Berlin Iron Bridge Company, was Connecticut's only major bridge manufacturer in the period. Headquartered in East Berlin, the company employed hundreds of iron workers in its extensive shop complex. Berlin Iron Bridge was a major supplier of highway bridges in the Northeast, and also provided many of the New Haven Railroad's rail bridges. In 1900, the company was absorbed into the American Bridge Company.



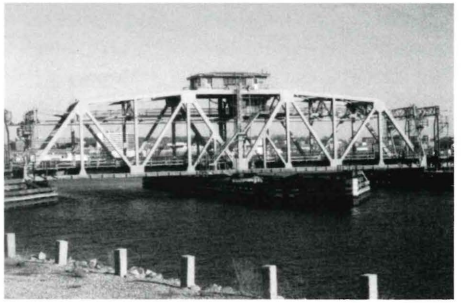

*Artist's view of Shaw's Cove in 1911 shows the extensive shipping that required a drawbridge for the railroad line.*



Over time, the nine-panel swing truss required many modifications, including structural reinforcement in 1917 and new gearing in 1917, 1924, and 1932. By the 1980s it had become severely deteriorated, and Amtrak replaced it with a modern truss swing bridge that captures some of the spirit of its predecessor.



*Detail of rollers, (HAER photo, 1978, by William Barrett).*

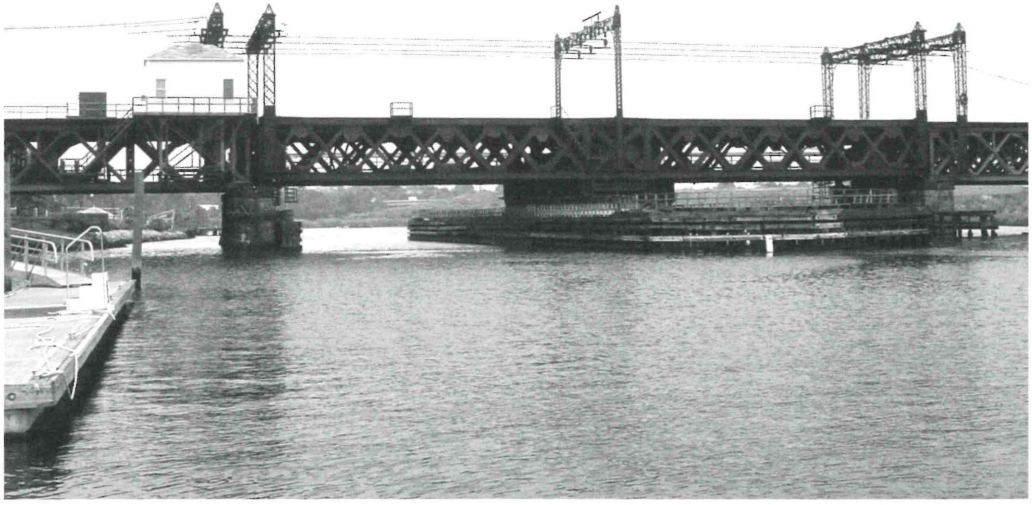


*Replacement bridge, 2002.*

# NORWALK RIVER RAILROAD BRIDGE (Bridge No. 4288R)

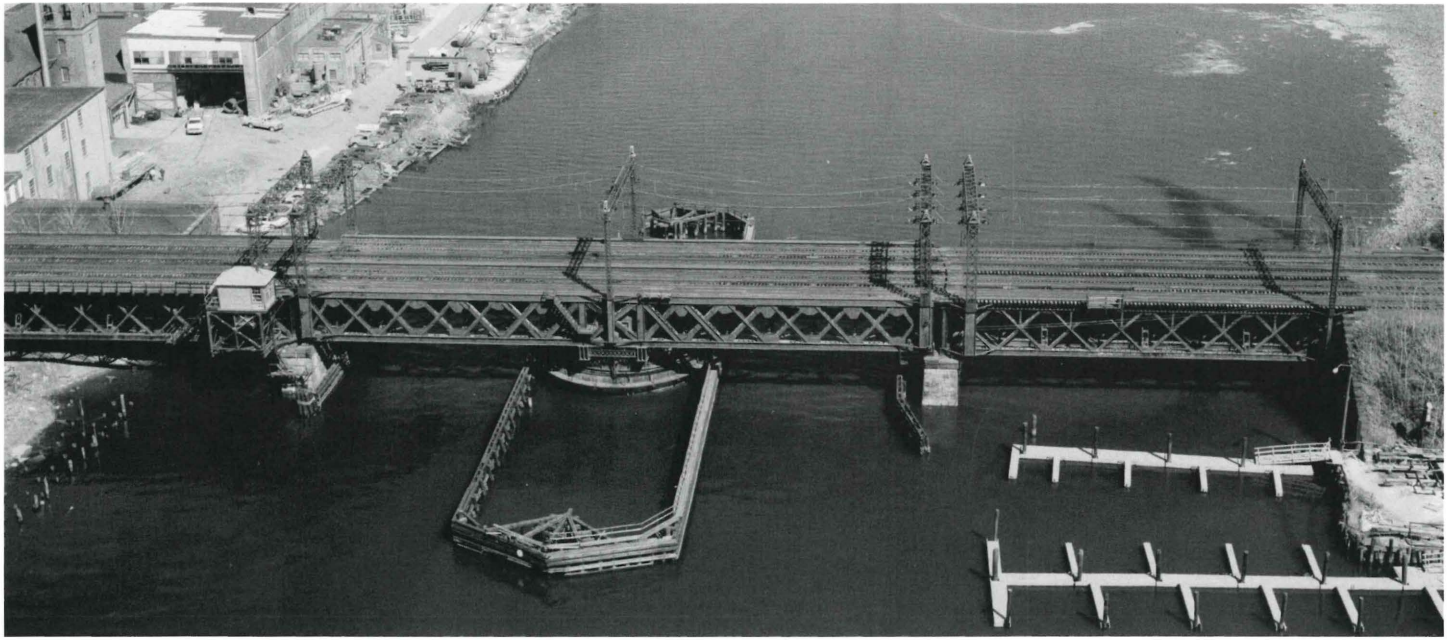
- Metro-North Railroad over the Norwalk River
- Norwalk
- Warren deck-truss rim-bearing swing bridge
- Length: 4 spans, 562' overall, 202' swing span
- Built in 1896
- Pennsylvania Steel Company, fabricator





The Norwalk River Bridge is the oldest movable bridge on the Northeast Corridor rail line in Connecticut and the only one of its type, a deck-truss swing bridge. It was built in 1896 at the time the New York, New Haven and Hartford Railroad was reconstructing its shoreline route. In addition to straightening curves and eliminating some grade crossings, the project doubled the width of the rail line from two tracks to four between New Haven and New York, rendering all the earlier two-track bridges obsolete. This bridge, designed just as bascules were coming into favor, probably represents close to the maximum of what was possible with the swing-bridge configuration. The movable portion's parallel trusses are of heavy box-girder construction to carry the weight of the massive steam locomotives then in use. The trusses are of the double-intersection Warren type, in which two sets of repeating triangles are superimposed, creating an X-shaped pattern. While some engineers objected to double-intersection designs because the distribution of stresses was somewhat indeterminate, railroads held them in high regard because they were extremely rigid, especially ones riveted together with heavy gusset plates as in this bridge. Trains run on wheels with just 1 1/8" of flange holding them to the tracks, so railroad bridges cannot be allowed to flex much at all.

The swing span's parallel trusses are carried on a large drum-shaped girder structure which in turn is



*Aerial view, HAER photo, 1977, by Jack E. Boucher.*

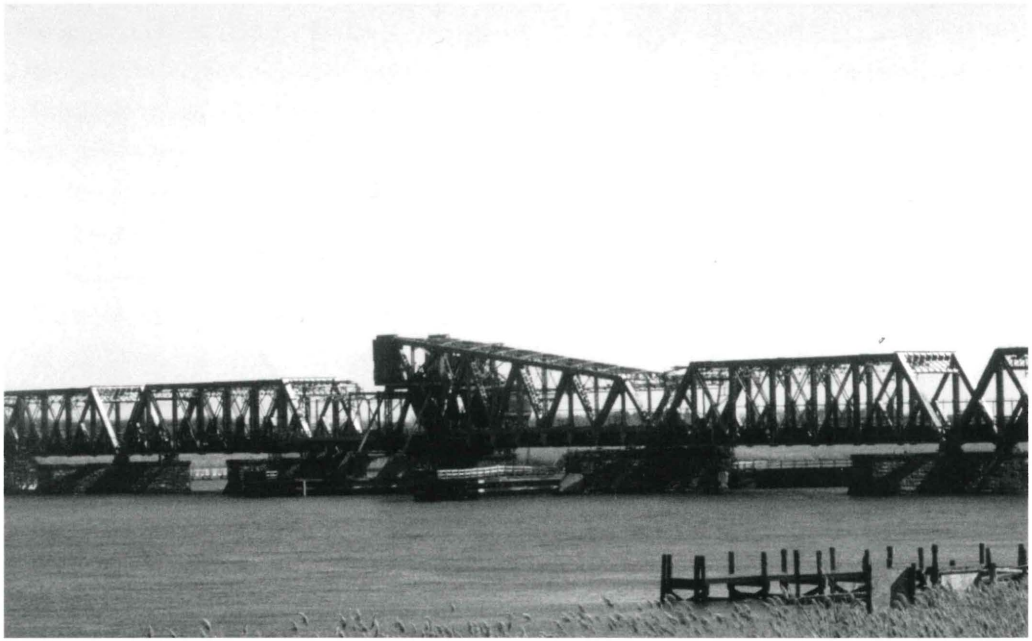


supported on 96 large rollers that run in a track atop the circular center pier. The bridge is operated by an electric motor that engages a ring gear along the circumference of the drum.

The location of this bridge is notorious in Connecticut history because of an incident involving an earlier bridge at the site. In 1853, an engineer, failing to notice the signal indicating that the drawbridge had been opened to allow a ship to pass, plunged his speeding passenger train into the Norwalk River. Forty-five people died, most from drowning, and the death toll might have been even higher had there not been among the passengers several physicians who were returning from a medical conference. It was one of the nation's deadliest railroad accidents to date. Out of this tragedy came the Connecticut Railroad Commission, an agency empowered to inspect the state's railroads and make recommendations for safety and operating regulations (among the first of which were stricter standards for stopping trains at drawbridges). The Railroad Commission was the direct forerunner of today's Connecticut Department of Public Utility Control.

# CONNECTICUT RIVER RAILROAD BRIDGE

- Amtrak - Shore Line East over the Connecticut River
- Old Lyme - Old Saybrook
- Warren through-truss Scherzer rolling-lift bascule
- Length: 10 spans, 1,535' overall, 158' bascule
- Built in 1907
- American Bridge Company, fabricator





Just as the Connecticut River is the state's largest river, so too this bridge has the greatest overall length of any of the state's railroad bridges, requiring seven 182-foot-long approach spans to reach the navigation channel. These identical Baltimore-type through-trusses are of heavy riveted box-girder construction. The Baltimore truss is a variant on the standard Pratt-type truss in which each panel is subdivided by an additional vertical member connected to the diagonal; the effect is to provide additional support beams for the tracks and thereby allow heavier loads.

The bascule is a Warren-type through-truss (with vertical members for additional support) of similar heavy riveted construction. Like the rail bridge over the Housatonic River, it has overhead counterweights and drive machinery, and it rolls back from the channel on huge curved girders. It is powered by an electric motor.

This portion of the shoreline rail corridor is only two tracks wide. Originally electrification ended at New Haven; then in the 1990s it was extended to Boston, so a catenary system for the overhead wires had to be installed on the bridges east of New Haven.

The rail line itself was opened in 1850 as the New Haven and New London Railroad, but for many years the trains were carried between Old Saybrook and Old Lyme on a ferry. Finally, in 1870, a successor company, the Shore Line

*Detail of roller segment, HRC photo, 1986.*

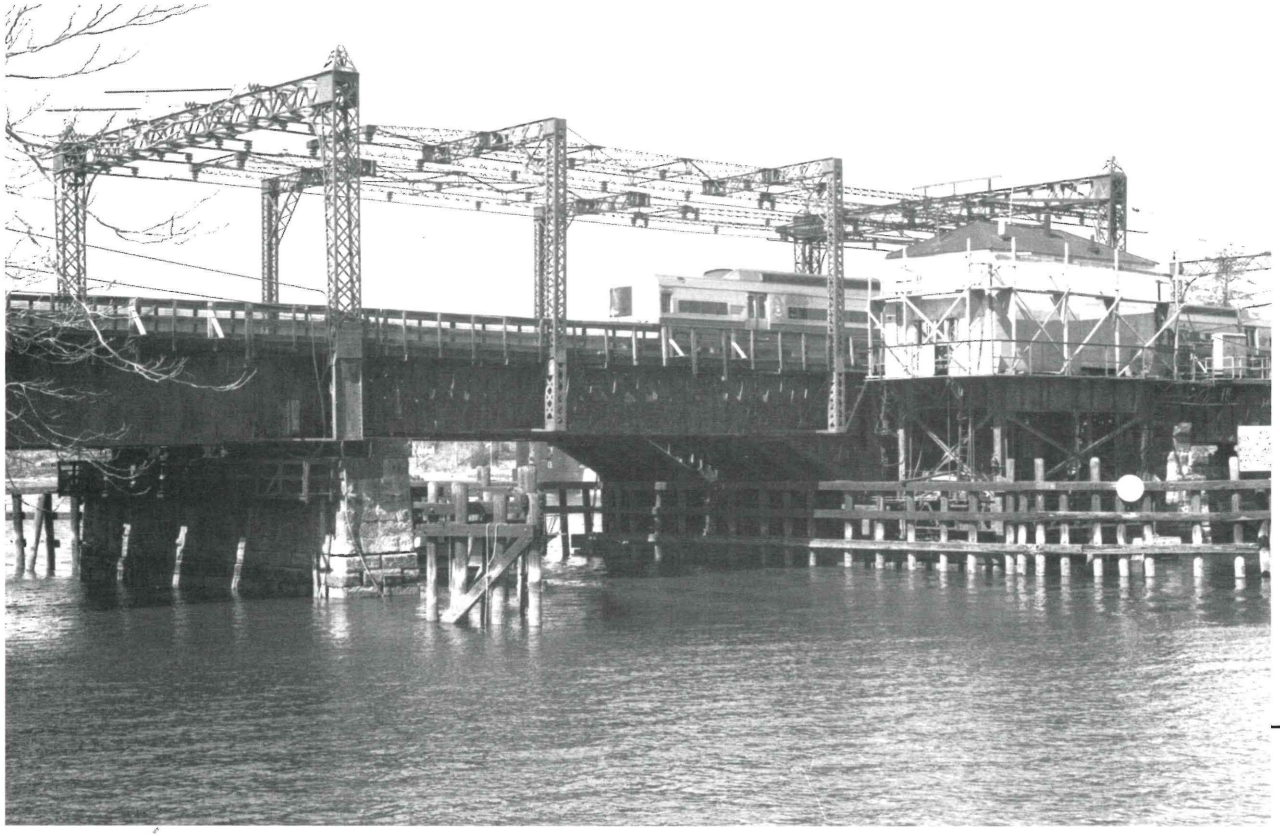
Railway, completed a costly drawbridge across the Connecticut River, whereupon the railroad was leased to the larger (and growing) New York & New Haven Railroad. The bridge was unpopular with maritime interests who saw it as an impediment to navigation. The Connecticut River was an important transportation resource at that time, with coastal vessels able to go upriver as far as Hartford. Even as late as 1907, when the present bridge was completed, the river carried a substantial traffic of barges loaded with sand, stone, coal and fuel oil. Passenger steamboat service between Hartford and New York City lasted until the 1930s.

# SAUGATUCK RIVER RAILROAD BRIDGE (Bridge No. 8032R)

- Metro-North Railroad over the Saugatuck River
- Westport
- Deck-girder Scherzer rolling-lift bascule
- Length: 6 spans, 458' overall, 98' bascule
- Built in 1905
- Pennsylvania Steel Company, fabricator

The Saugatuck River Railroad Bridge, located about a mile downriver from the historic 1884 Saugatuck River highway swing bridge, is one of several Scherzer rolling-lift bascules along Connecticut's Shoreline rail corridor, a busy four-track line that serves both Amtrak and New Haven commuter trains. Like the Cos Cob bascule, the Saugatuck crossing consists of two parallel two-track deck-girder bascules that operate independently of each other. The approach spans are also of deck-girder construction.

Although similar in overall configuration and the strength of construction (these bridges were designed to handle the heavy steam locomotives of the era), no two of the shoreline bascules are exactly alike. The Saugatuck River Railroad was unique because it was originally powered by two diesel engines rather than electric motors. The engines, which had fluid torque-converter transmissions, were located at track-level inside the operator's house just east of the movable span. Power was transmitted from the operator's house to the movable spans by means of shafts and gears, with the final operating effect carried out by a pinion, mounted to the moving span, that engaged a fixed rack. In the Scherzer design, the bridge not only lifts up at one end but also actually rolls away from the channel on large curved segmental girders. Consequently, the drive pinion moved away as well,



necessitating a telescoping section in the drive shaft so as to maintain engagement.

*HRC photo, 1986.*

# GLOSSARY

**Abutment**
Stone or concrete structure that supports the end of a bridge, usually built into the bank of a waterway.



**Angle**
A basic form used in metal bridges, both individually and to make up girders, having a right-angle as its cross-section. Angle iron is produced in lengths by rolling mills.

**Approach span**
A minor span at the end of a bridge that is small compared with other parts of the bridge.

**Ashlar**
A type of masonry made up of squared-up blocks of stone (as opposed to irregularly shaped pieces or fieldstone), used for abutments and piers.

**Bascule**
A type of movable bridge that pivots (or rolls) at one end, allowing the other end to rise up in the air; medieval castle drawbridges were bascules.

**Brown bascule**
Any of several patented designs by Thomas E. Brown, characterized by a complex operating linkage in which the leaf moves a greater distance than the counterweight.

**Camelback truss**
A Pratt truss in which the top chord is five-sided in profile; by making the truss deeper in the middle than at the ends, the Camelback design saves on material and overall weight.

**Cantilevered**

Descriptive of a portion of a bridge that hangs out over the rest of the structure, such as a sidewalk that is supported on extensions of the floor beams.

**Catenary**

The system of overhead wires and supports that allows the electrification of a railroad line.

**Center-bearing**

A type of swing bridge in which the weight of the moving span is supported at the center, typically by a special metal bearing, such as phosphor bronze. See also rim-bearing.

**Chords**

The upper and lower horizontal members of a truss, between which run vertical and diagonal members that transfer forces from the bridge to the abutments.

**Counterweight**

A large, heavy mass of concrete or metal that serves to balance the weight of the movable span, so that the motor and operating mechanism need provide only a small amount of force to move the bridge.

**Dead load**

The weight of a bridge without vehicles traveling across.

**Deck truss or girder**

Type of bridge in which the traffic surface rests on top of the support system; only railings or guardrails extend above the level of the roadway or tracks.

**Eyebar**

A structural form, either bar or rod-shaped, having ends with a circular opening, commonly used as a diagonal member in trusses with pinned connections.

**Fixed span**

A component of a movable bridge that does not open.

**Girder**

1. A beam, usually I-shaped in section, made up of individual pieces of metal that are riveted or welded together. The most common type is the plate girder, made up of a length of thick iron or steel plate with paired angles at the top and bottom forming flanges and usually stiffened in the middle (the web) with additional vertical angles.
2. A span that uses a pair (or more) of girders as its chief structural component, as opposed to a truss.



**Leaf**

The part of a bascule that moves up and down; most bascules have a single leaf, but large ones may be double-leaved, in which case the bridge can open from both sides.

**Live load**

The weight of the vehicles, passengers, and cargo capable of being supported by a bridge.

**Pier**

An intermediate support for a bridge, usually some form of masonry, between the abutments at the ends.

**Pinned connections**

A method of truss construction in which the major structural members are connected by large pins (typically 3 or 4 inches in diameter) that are then secured with nuts; typical of 19th-century bridges.

**Pinion**

A small gear that meshes with a much larger gear, such as the powered gear that operates a movable bridge by meshing with a ring gear or a set of reduction gears.

**Plate girder** - see Girder

**Pratt truss**

A common truss type made up of vertical members that resist compressive forces and diagonals that resist stretching forces.

**Rim-bearing**

A type of swing bridge in which the weight of the moving span is carried on large rollers set into a circular track. See also center-bearing.

**Riveted connections**

A method of truss construction in which the major structural members are joined by being riveted to large plates called gussets, typical of post-1900 trusses.

**Scherzer rolling-lift bascule**

A patented type of movable bridge in which the leaf rolls back on a large curved girder rather than pivoting on a trunnion; the result is that the leaf both rises up in the air, like other bascules, but also is pulled back somewhat from the navigation channel.

**Span**

1. A structurally independent component of a bridge; movable bridges typically have one movable span over the navigation channel and several fixed spans leading up to it.
2. A measure of length, the distance between support structures such as piers or abutments.

**Strauss bascule**

One of a series of patented designs characterized by a large trunnion on which the leaf pivots and a pivoting counterweight.

**Stringer**

Any horizontal structural member, usually referring to one of a series that run between floor beams so as to support the roadway.

**Swing bridge**

A movable span which pivots in a horizontal plane, usually at the center, opening so as to parallel the waterway and clear a channel on either side of the pivot.



**Through-truss or girder**

Type of bridge in which the traffic is carried between the major structural components.

**Trunnion**

The large shaft and bearings upon which the leaf of a bridge pivots.

**Truss**

1. A type of bridge in which individual structural forms such as I-beams are connected together to form a larger support system. 2. The individual support systems making up such a bridge; a truss bridge usually has two parallel trusses on either side of the roadway. 3. The particular arrangement of structural members that characterizes a design such as the Pratt or Warren truss.

**Warren truss**

A common type of truss in which the diagonal members run in alternating directions between the top and bottom chords, creating a profile of triangles. Vertical members, if present, are secondary.

# BIBLIOGRAPHY


Clouette, Bruce, and Matthew Roth.
*Connecticut's Historic Highway Bridges.*
Wethersfield, Conn.: Connecticut Department of Transportation, 1991.

Hool, George A., ed.
*Movable and Long-Span Steel Bridges.*
2nd ed. revised (orig. pub. in 1923). New York: McGraw-Hill Book Company, 1943.

Hovey, Otis. *Movable Bridges.*
New York: J. Wiley & Sons, 1927.

Roth, Matthew W.
*Connecticut: An Inventory of Historic Industrial and Engineering Sites.*
Washington D.C.: Society for Industrial Archeology, 1981.

Turner, Gregg M., and Melancthon W. Jacobus.
*Connecticut Railroads: an Illustrated History.*
2nd ed. Hartford: Connecticut Historical Society, 1989.

Waddell, J. A. L.
*Economics of Bridgework, a Sequel to Bridge Engineering.* New York: J. Wiley & Sons, 1921.

Wright, George E.
*Crossing the Connecticut: An Account of the Various Public Crossings of the Connecticut River at Hartford since the Earliest Times.*
Hartford: The Smith-Linsley Company, 1908.

# MOVABLE BRIDGES IN CONNECTICUT

## Listed on the National Register of Historic Places as of June 2004

Pequonnock River Railroad Bridge, Bridgeport, Scherzer bascule, 1902

Mianus River Railroad Bridge, Cos Cob, Greenwich, Scherzer bascule, 1904

Housatonic River Railroad Bridge, Milford-Stratford, Scherzer bascule, 1904

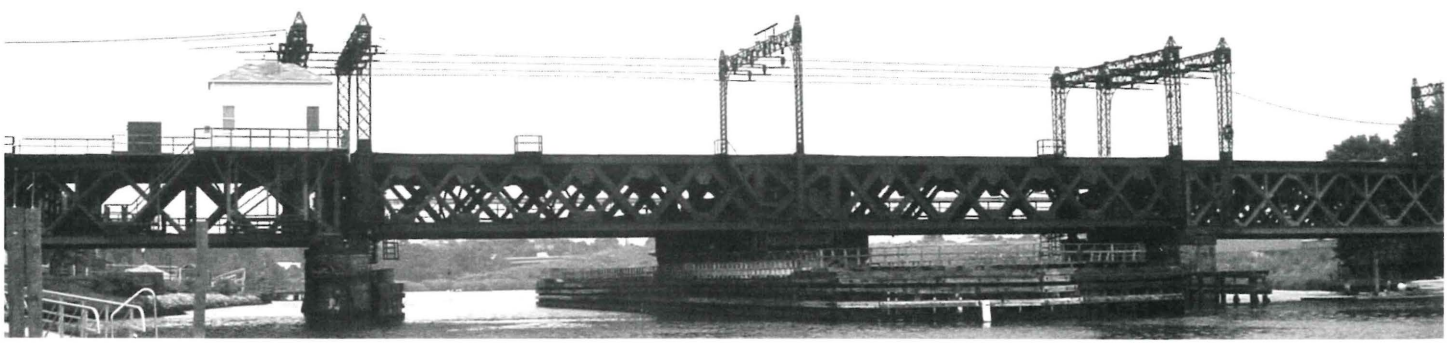
Norwalk River Railroad Bridge, Norwalk, Warren-truss swing bridge, 1896

Saugatuck River Bridge (Bridge No. 1349), Route 136, Westport, Pratt-truss swing bridge, 1884

Saugatuck River Swing Railroad Bridge, Westport, Scherzer bascule, 1905

Most of the remaining historic movable bridges in Connecticut have been determined to be eligible for the National Register of Historic Places but for various procedural reasons have not been formally listed. Determination of eligibility affords a resource the same protection as actual listing in terms of impacts from federally funded projects.





*Norwalk River Railroad Bridge*

# MOVABLE BRIDGES IN CONNECTICUT

## Recorded by the Historic American Engineering Record (HAER)

East Washington Avenue Bridge (Bridge No. 4252), Pequonnock River, Bridgeport, Strauss bascule, 1925 (HAER No. CT-154), replaced.

Grand Street Bridge (Bridge No. 4250), Pequonnock River, Bridgeport, Strauss bascule, 1919 (HAER No. CT-148), removed.

Yellow Mill Bridge (Bridge No. 3637), Stratford Avenue over Yellow Mill Channel, Bridgeport, bascule, 1929 (HAER No. CT-146).

Niantic River Railroad Bridge, East Lyme-Waterford, Scherzer bascule, 1907 (HAER No. CT-27).

Niantic River Swing Bridge (Bridge No. 1397), Route 156, East Lyme-Waterford, Warren-truss swing bridge, 1921 (HAER No. CT-22), replaced.

Mystic River Bridge (Bridge No. 362), U.S. Rt. 1, Groton-Stonington, Brown bascule, 1922 (HAER No. 174).

Mystic River Railroad Bridge, Groton-Stonington, Warren-truss swing bridge, 1919 (HAER No. CT-26), replaced with modern replica.

Thames River Railroad Bridge, Groton-New London, Strauss bascule, 1919 (HAER No. CT-25).

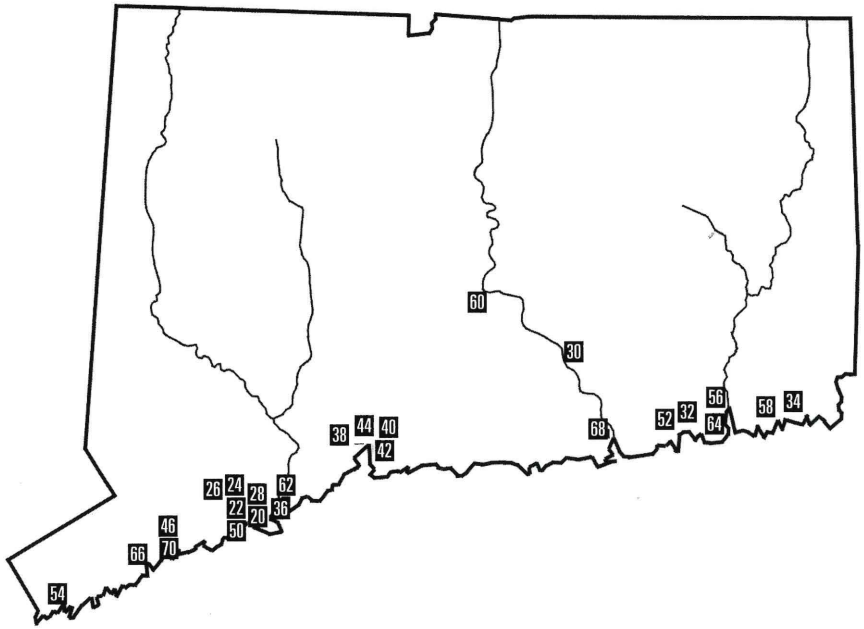
Tomlinson Bridge (Bridge No. 337), Forbes Street over Quinnipiac River, New Haven, Strauss bascule, 1924 (HAER No. CT-61), replaced.

Chapel Street Swing Bridge (Bridge No. 3807), Mill River, New Haven camelback-truss swing bridge, 1899 (HAER No. CT-42), replaced.

Shaw's Cove Railroad Bridge, New London, Pratt-truss swing bridge (HAER No. CT-24), replaced with modern replica.

Saugatuck River Bridge, Route 136, Westport (Bridge No. 1349), Pratt-truss swing bridge, 1884 (HAER No. CT-46).

# INDEX MAP






*Bridges included in this book, listed below in order by town. Numbers refer to page numbers in this book.*


| | | |
|---|---|---|
| Bridgeport | Congress Street Bridge | 22 |
| Bridgeport | East Washington Avenue | 24 |
| Bridgeport | Grand Street Bridge | 26 |
| Bridgeport | Pequonnock River Railroad Bridge | 50 |
| Bridgeport | Pleasure Beach Bridge | 20 |
| Bridgeport | Yellow Mill Bridge | 28 |
| East Haddam-Haddam | East Haddam Swing Bridge | 30 |
| East Lyme-Waterford | Niantic River Swing Bridge | 32 |
| East Lyme-Waterford | Niantic River Railroad Bridge | 52 |
| Greenwich | Mianus River Railroad Bridge | 54 |
| Groton-New London | Thames River Railroad Bridge | 56 |
| Groton-Stonington | Mystic River Bridge | 34 |
| Groton-Stonington | Mystic River Railroad Bridge | 58 |
| Middletown-Portland | Middletown Railroad Bridge | 60 |
| Milford-Stratford | Housatonic River Railroad Bridge | 62 |
| Milford-Stratford | Washington Bridge | 36 |
| New Haven | Chapel Street Swing Bridge | 38 |
| New Haven | Ferry Street Bridge | 40 |
| New Haven | Grand Avenue Swing Bridge | 44 |
| New Haven | Tomlinson Bridge | 42 |
| New London | Shaw's Cove Railroad Bridge | 64 |
| Norwalk | Norwalk River Railroad Bridge | 66 |
| Old Saybrook-Old Lyme | Connecticut River Railroad Bridge | 68 |
| Westport | Saugatuck River Swing Bridge | 46 |
| Westport | Saugatuck River Railroad Bridge | 70 |

océlia